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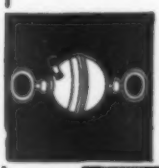

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The Shifting Focus of Science

THE shifting focus of scientific interest has received scant attention either from historians or from men of science. The temptation always is to study the changing scene in terms of its great figures, to believe, in atomistic fashion, that each problem is born of the personal intellectual interest of the individual man of science ; that it has been brought to the notice of his contemporaries by a pure but inexplicable effort of imagination. While it is true that creative thinking of an individual nature must play its part in the making of science, it is equally obvious that the movement in interest cannot possibly be wholly accounted for, on this basis. The problems of Faraday and Maxwell were beyond the imagination of Newton, and those of the modern period outside the mental scope of all three. This does not mean that Faraday and Maxwell were greater figures than Newton, but rather that no man of science can do other than concern himself with the problems characteristic of his period.

The changing face of science can be seen without difficulty to fall into clearly defined stages. We have just suggested three. Each phase is carried through by the activity of the individual scientific workers, great and small, contributing in various measures, partly driven on by the developing internal logic of the subject and its accumulating experimental knowledge, partly canalized and fed by outside social forces not normally apparent to the individual workers. How scientific work is financed, and for what social purpose that work is pursued, for example, is a question the answer to which, in these days of industrial and governmental research, points to one only of the socially determining factors. The shifting focus of science, however much it may provide subjective satisfaction to its devotees, is nevertheless an objective feature of Nature, and therefore, if for that reason alone, a fit subject for scientific investigation.

To-day we are witnessing just such a shift. It began tentatively in the early days of this century with a scrutiny of the logic of mathematics and a study of the methodology of science. It passed to a series of startling attempts to evaluate the philosophical implications of more recent scientific knowledge, implications that sought to deny the certainty of science and strove to lead it back into mysticism. The significant feature of this phase was that these pronouncements were couched in popularized writings, a concession to a sense of social responsibility. Now at last a serious attempt is being made to probe further back to the social origins and social consequences of scientific discovery. The alertness shown in the columns of NATURE to the social possibilities of science, to its destructive as well as its constructive features, to the travesties of truth that are used to bolster up national doctrines, and generally to the distortion and prostitution of science to ignoble ends, is itself a significant feature of this same analysis. Scientific history, like ordinary history, is at last beginning to be seen in its social context ; and the shifting focus of science is part of its history.

The new concern of men of science with the uses and misuses of science has undoubtedly developed with the increasing tenseness of the international situation. The concern of this journal with these matters evidently derives from this source, but did not in fact become apparent until the latter had reached a critical stage. Nevertheless, the social background was always there for study. It required a social crisis to direct our attention to it.

Every shift in interest of science is accompanied by opposition on the part of those absorbed in the older problems and convinced that the new development leads away from the true path of scientific rectitude. A multitude of specious reasons are certain to be brought forward to show that political prejudice must necessarily intervene to prevent the formation of balanced judgments. Such considerations need not deter those who are genuinely concerned with the trend of scientific development as a feature of natural change.

The personal motives that urge individuals rather than the group to concentrate on such questions when the time is socially ripe for their study are many. In "Mathematics for the Million"*, for example, the author is apparently induced to do so in order to take the mystery out of mathematics, and to open the door to an understanding of its meaning for the ordinary citizen. How mathematics could be anything but a mystery to those who have not perceived its social sources is itself a mystery. In this respect, it is sufficient of a miracle to many scientific workers. To mathematicians who do not see it as one of the forms of social energy, it can have but a restricted meaning. In his own way, Hogben has established beyond dispute the existence of a qualitative relation between the growth of mathematical facts and the severely practical problems of the society that gave them birth. That is in itself a significant scientific advance. What requires further elucidation is the changing nature of this relationship.

In its early history, society encountered quite definite immediate problems that required for their solution a definite mathematical technique. By the eighteenth century, the situation in this respect had become drastically transformed. The new merchant and industrial aristocracy was purchasing social prestige by the endowment of university foundations, and educational institutions generally. While out of the practical needs of social life there had blossomed forth the earlier mathematics that dealt with the directly important problems of mensuration, experimental practice had also been called into being for these same ends: and experimental practice involves theory, and theory its mathematical technique, and mathematical technique its special tools and its specific logical problems. To such questions could the universities devote themselves, but the linkage with the severely practical problems of social life, the problems of the common man, while it still existed, had become more remote. The danger for us lies in the belief that that link no longer exists, a belief that shows itself in the idea that mathematics is an independent logical discipline with an absolute line of cleavage between its pure and its applied form. It shows itself in the effort to accord to mathematical ideas a priority over the physical facts of the world and so to present the universe and the struggling society on this earth as a series of grandiose mathematical theorems. Hogben's book is not a mathematical text-book except in a very popular sense—in itself a very important sense—but if its publication should serve to direct attention to the social linkages between the sciences, it will have performed a very significant service. H. L.

* Mathematics for the Million. A Popular Self-Educator. By Lancelot Hogben. Revised second edition. Pp. 658. (London: Allen and Unwin, Ltd.) 12s. 6d. net.

The End of the Road

A Comprehensive Treatise on Inorganic and Theoretical Chemistry

By Dr. J. W. Mellor. Vol. 16: Pt. and General Index. Pp. x + 811. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1937.) 63s. net.

THE road of inorganic chemical knowledge is paved with bricks, of silver and sodium, lithium and lead, platinum and phosphorus, helium and uranium, representing all the elements which Mendeléeff provided for and more besides, as well as their numerous compounds; it is surfaced with what road experts call a binder, but which we, the initiated, designate as 'Mellor's magic', a highly original and individual variety. Slowly the magic has prevailed, as good magic always must when diligently applied, and so at last the end of the road has been reached—index and all. Riders in quest of knowledge can traverse it from end to end: it has been well and truly printed.

In more prosaic language, Mellor's "Comprehensive Treatise" is completed: in fifteen years, the vast field of inorganic chemistry has been surveyed. Such an achievement ought to be a

matter of national congratulation and every Britisher should be proud that there exists such a treatise in his own language. His continental scientific colleagues have for some years borne the burden of similar publications in chemistry, thereby ensuring a large amount of cultural propaganda; for this reason alone, it is most pleasing that there is now a work of outstanding excellence which will spread abroad British scientific culture.

That the book is outstanding has already been demonstrated in the previous fifteen volumes; its preparation, even if it has become a matter of routine, has involved a tremendous amount of hard work of an extremely conscientious character, coupled with the ability to seize the essentials and classify the material in a form which makes it easy of access for the reader.

Chemists, and indeed that far wider circle of persons in any way concerned with inorganic substances, now have a timely opportunity to testify to the debt of gratitude they owe to Dr. Mellor. The task he has undertaken, as anyone who has done work of this kind knows, has been not merely an occupation but something much more strenuous amounting to a whole-time job and the sacrifice of leisure; if it had not been a labour of love, its completion would have been indeed impossible. As it is, one can only hope that the sacrifice of fifteen years at an important period of a man's life has carried with it some recompense and reward to the author. The more thoughtful who consult the book to-day and in the years to come will spare perhaps a moment to think gratefully of him; the hasty will omit even this much unless they fail to find the particular information in the detail and form they want, when perhaps they too will realize the magnitude of the task.

The day is long since past when any man can know all chemistry or even one branch of it; although sitting as honours students, the examiners do expect us to qualify in regard to the questions they set at random. It should become clear when these sixteen volumes are set out in stately array on the shelf that the function of education is to teach first the fundamentals, then how to find the information, to know how it has been obtained, to be able to criticize it and utilize it to the desired ends. The amount of new work published every year has now to be measured in yards of shelf room occupied instead of in feet, and the resources and organization of the societies engaged in producing abstracts are strained to breaking point. General reading has become largely impossible, a most regrettable feature; specialist reading is helped by monographs and annual reports. One result is that the learned transactions no longer have their former appeal to any considerable number of members of a society, so that while their cost is increasing, the membership grows less. This is not the occasion on which to suggest any remedy for the trouble, which is a world-wide one and has already become acute.

Fortunately for the worker or specialist, whether in academic or industrial practice, there still exists a limited number of people, of whom Dr. Mellor is the outstanding British example, who are not dismayed by the magnitude of the task and are willing to collect information in a form and according to a plan which makes it easy of access. By arrangement according to certain conventions, by the use of black type and other simple devices, it is not difficult to trace the paragraph giving the desired information.

Dr. Mellor has a somewhat unusual mixture of talents. Few of those who form a mental picture of him as the result of their study of the "Inorganic Chemistry" would recognize him as the author of a book entitled "Uncle Joe's Nonsense", in which he displays high ability as a humorist both in text and illustration. The reviewer greatly values a set of menu cards, for which "Uncle Joe" was responsible, from the *Laconia* on the occasion of the visit of the Ceramic Society to America. It may be that these talents have contributed to make the treatise what it is, so much more than a dictionary or compendium, actually readable in parts and definitely original.

It has been so often reviewed that the resources of the literary flower shop have been largely exhausted in throwing bouquets which the author must be satiated to receive.

The late Prof. H. E. Armstrong was one of its admirers; he used to say it helped you to read chemistry, which he regarded as a most important as well as practically a lost attribute of the chemist. He himself attached much importance to critical reading, in which the reader did not merely accept the statements but also developed his intelligence in seeking to understand their implication.

This volume contains the index to all the volumes, 400 pages in double column, prepared by Miss E. M. Rigby, which gives reference both to each individual compound and to more general topics such as catalysts.

The author is loath to write finis, for we are promised two supplementary volumes which will include the developments and discoveries of recent years, particularly those relating to the elements which were treated in the early volumes. In addition, Mellor is unwilling to leave all compounds of carbon to the organic chemist, and therefore proposes a special volume to deal with the borderland compounds of carbon with hydrogen and nitrogen.

E. F. A.

Animals in Ancient Rome

Animals for Show and Pleasure in Ancient Rome
By George Jennison. (Publications of the University of Manchester, No. 258.) Pp. xiv + 209 + 8 plates. (Manchester: Manchester University Press, 1937.) 12*s*. 6*d*. net.

THIS is a remarkably interesting book owing to the fact that the author combines the qualifications of being a scholar and an official of the Bellevue Zoological Garden at Manchester. Mr. Jennison's book has an extraordinarily widening influence. No one before—certainly in English—has been at pains to collect from all classical sources the notices of wild animals brought for any purpose to ancient Rome—for the games, for menageries or as private pets. The result is a brilliant justification of taking up a rather out-of-the-way line of research. It is not only illuminating in itself but also sheds light on all the surrounding subjects—the character of the Roman people and of their successive emperors, the trade-routes and the spread of Roman influence in the ancient world, the climatic and other changes in the countries from which the beasts were drawn.

Another special merit of the book should be noted. Being written by a man in professional intimate contact with the wild beasts and birds of which he writes in the ancient world, it is full of interesting touches about their life and habits, which show how little these have changed. The men have changed more than the beasts. Mr. Jennison tells us of the weak spot in lions—the backbone just above the loins ("I have known two lions killed unintentionally by a blow there from a broomstick") and then shows how well this fits in with the description in the poet Statius of the death of a trained lion in the arena. He knows how difficult it is to train stags to go in harness and applies this to the procession of the maiden priestess of Artemis in a car drawn by stags and described by Pausanias in the second century A.D. He knows the difficulty of breeding leopards in captivity and a host of other things which bring into high relief the skill, patience and expense expended in the Roman world for the production of their great beast shows and *venationes*. He is equally well informed on the domestic side of the culture of animals by the ancient Romans, telling us, for example, how much the breed of chicken has improved in modern times, as the ancient hen would only at the best lay her sixty eggs a year.

The absorbing interest of the book, however, is its description in detail of how the animals were used for show and slaughter in the arena. It is on the whole a revolting tale, for though there was much training of the beasts for wonderful tricks (lions that would hold hares in their mouths without biting them, dancing horses, monkeys playing draughts, etc.), yet the predominant motive was the popular passion for the sight of deadly sports. The apologists for the Romans trace back this passion to the Etruscans, who seem to have practised gladiatorial games. But the Romans improved on their masters in this respect as in others, and there was little abatement in the passion until the poverty and the Christianity of the later Empire gradually led to the emptying of the arena.

The games, including the slaughter both of men and animals, was the recognized way in which generals and leading magistrates aimed at popularity. Larger and larger numbers of beasts were collected from the provinces and stranger and stranger creatures sought for, to make each *venatio* more distinguished. Elephants were first introduced in the third century B.C. for the triumph over Pyrrhus and became the 'royal beast', to be owned only by persons of the highest rank. They were, however, used not only for ceremonial and warlike purposes but were also slaughtered in the circus. This was so horrible and pathetic a sight that even the Roman crowd protested. They rose and cursed Pompey, who had provided this delicacy, and Cicero, who always expressed the best feeling of his time, wrote to a friend that there was some sort of kinship between that animal and man. Julius Cæsar brought in the giraffe, but there is no evidence of its slaughter until the time of Commodus—a sign both of the gradual worsening of the popular taste and of the mad-dog character of the man.

Nothing is more striking in the story than the reaction of this popular passion for bloodthirsty games on the minds of the rulers who provided, and were responsible for, them. The worst—Nero, Commodus and Elagabalus—revelled in them and often took part themselves. But none was strong enough to make a stand and reform the whole wasteful and abominable system. Trajan, who as ruler was the ablest and most successful of the line, inaugurated his reign by making a public demonstration of simplicity and economy by entering Rome without a procession, without a chariot, without even a horse. The populace saw a tall powerful upright man pass up the Via Sacra on foot accompanied by his wife and a few personal friends. His well-known rescripts on the right method of treating Christians in the provinces are

a model of humanity and good sense. Yet the same man in A.D. 107, celebrating his Dacian triumph, authorized games for 120 days, during which 10,000 gladiators fought and 11,000 animals were done to death. Marcus Aurelius, whose instincts revolted against the shows, actually attended some of the most brutal, though he turned his back when the specially well-trained man-eating lion was performing his feats.

Of all such sensational facts Mr. Jennison gives us enough, but not too much, and his book is, besides, a fascinating storehouse of the natural history of the ancient world. When the first chimpanzee was seen in Greece; were polar bears ever transported to Rome; how the crocodile is the easiest of all wild animals to trap; how long were lions extant, wild, in Europe. The book is a rare model of minute and extensive scholarship combined with practical knowledge, good judgment and clear arrangement. The production also sheds great credit on the Manchester University Press.

F. S. MARVIN.

Nuclear Physics

Structure of Atomic Nuclei and Nuclear Transformations

By G. Gamow. Being a second edition of "Constitution of Atomic Nuclei and Radioactivity". Pp. xii + 270. (Oxford: Clarendon Press; London: Oxford University Press, 1937.) 17*s*. 6*d*. net.

IN the preface it is stated that whereas in writing the first edition the author felt unhappy because there were not enough experimental facts and theoretical calculations, he now feels there are perhaps too many. Indeed, nuclear physics has undergone an enormous change since the publication of the first edition, of which in the present edition nothing but the memory is preserved.

At that time the author was one of a few pioneer workers in the field, the number of problems that could be understood was strictly limited, and the book was mainly intended to show the applicability and usefulness of quantum theory in nuclear problems, together with a fuller account of the passage of charged particles into and out of the nucleus, which, thanks to his own work, was then already well understood.

The rapid development which followed the discovery of new experimental facts and new particles, but which owes much to Prof. Gamow's early work, brought innumerable other workers into the field, which has now lost much of the charm of the unexplored and has become rather more a branch of theoretical physics. Although the book is still more concerned with the general ideas than with too detailed applications, it has to deal with work in a wide field, done by different people with different methods and different (usually mutually exclusive) approximations. This makes such a general report a very necessary but at the same time a very difficult task to undertake. We are very fortunate that it was undertaken by a man like Prof. Gamow, of whom we can confidently expect a lively account which will not entangle us in a jungle of mathematical detail but will pick out the main ideas and use simple pictures as much as possible. It is very refreshing to read such passages as the account of work on the "shell structure" of nuclei: ". . . it is not referred to in detail here because the author was never able in studying these articles to remember the beginning when he was reading the end." This is in the best Gamow tradition, and we can only regret that there are too few passages of this kind. On the whole, the author is more serious, more the impersonal and impartial reporter than before.

One of the difficulties that such a reporter has before him is to steer the good middle course between assuming all the mathematical apparatus of quantum theory to be familiar to the reader (which would make the book lose its appeal to experimentalists) and to explain the methods wherever they are applied (which would bring it to about the same size as another recent book in the same series). This is evidently a matter of taste, but to the reviewer's taste one meets rather too frequently expressions such as "Simple considerations show . . .", where a few words would have been sufficient to make clear what the nature of these considerations were, or where a reference to a text-book could have been given. In general, references are treated rather casually; papers are often indicated by "it has been shown that . . ." and even when we are given the name of the author, it is often not said where and when he has shown it. In two cases (pp. 128, 173, 219) the footnotes send unsuspecting students off to the library on a wild-goose chase for non-existing periodicals, and only the initiated will understand the subtle jokes.

It is unfortunate that in one or two instances in which the reader has to take it on the author's authority that something "can be shown", slips have occurred. For example, on p. 54 the "very intense" fields referred to are of the order of 100 gauss; the Dirac wave equation is not the only possible Lorentz invariant equation for a particle

(p. 60); the definition of 'odd' and 'even' terms in the footnote on p. 71 is rather confusing. A mass-spectrograph is not usually employed to measure particle velocities, and an elementary particle of spin ½ is not normally referred to as a "rotator".

A good book takes some time to write and publish, and with the present rapid development of the subject it is unavoidable that some passages should be out of date by the time the book is published. In this case, the book was written immediately before the publication of Bohr's theory, which not only opened the way for solving problems that had before remained unexplained but also made it clear beyond doubt that the one-body picture (motion of one particle in a suitable potential field) is entirely inadequate except for such problems as the passage of a charged particle through the potential barrier surrounding a charged nucleus. Prof. Gamow warns us against the excessive use of this method (pp. 200, 208). Yet in many places the old optimism of this strong adherent of the one-body picture breaks through. An attempt at justifying a moderate use of the picture is made in the preface on the grounds that a more complete treatment would be very complicated if not impossible. But if one has reason to believe that some results are independent of the one-body picture, it ought to be possible to derive them without it; and if one has no such reasons, the validity of a method cannot be established by the argument that there is no better method available.

The new Bohr theory has already led to many new results, and has thus greatly increased the wealth of material which Prof. Gamow deplores in his preface. Let us hope that future development, by deciding which are valid and which invalid approximations, and by elimination of unreliable speculation, will reduce the bulk of papers he will have to read before writing the next edition.

Dr. Feather is to be congratulated on succeeding in putting the book into the chains of "orthography and conventional idiom" without spoiling its freedom of expression and its liveliness. R. P.

Plant Ecology in Education

(1) Plant Ecology
By Hilda Drabble. Pp. 142 + 12 plates. (London: Edward Arnold and Co., 1937.) 7*s*. 6*d*. net.

(2) Ecology in Town and Classroom
By Dr. R. Bracher. Pp. 96 + 3 plates. (Bristol and London: J. W. Arrowsmith, Ltd., 1937.) 2*s*. 6*d*. net.

THE increasing replacement of the older teaching of a somewhat disjointed nature study by a more truly scientific course in ecology in schools and colleges has resulted in the need for text-books to serve both the teacher and the student. The two publications here noticed are very dissimilar in aim and content.

(1) Mrs. Drabble's book carries the subject, for plant ecology of the British Isles, approximately, though with several important exceptions, to the general B.Sc. standard of the University of London. It is a concise and adequate summary of much of the more important research on the synecology of plant communities published within recent years, and as such can be strongly recommended to both teachers and students. The twelve plates, mostly from photographs by Prof. E. J. Salisbury, illustrate relevant facts concerning the composition and history of a wide range of types of vegetation. The forty-five test questions should enable students to estimate their knowledge of the subject in advance of examinations and to familiarize themselves with the, usually very fair, type of questions set for them to answer.

There is some justification for the criticism that such a book 'spoon-feeds' the student too much. It is suggested that, if another edition be called for, more emphasis should be placed on practical work by the students themselves. Plant ecology offers a wide scope for investigations in the field, the experimental garden, and the laboratory, and it is advisable that students should be urged to solve its problems by their own experience. The study of the life-histories of single plant-species (autecology) should also be encouraged, and general suggestions for such research might well have been included, with one or two actual examples.

(2) Dr. Bracher's book is limited in scope. It is complementary to her "Field Studies in Ecology" published, in a similar format and at the same price, in 1934. It deals, in brief outline, with the botany, from an ecological point of view, of streets, waste ground, coal tips, fresh waters and tidal river banks. The teacher in a town school should obtain useful ideas from reading its pages. In many towns, at least in the suburbs, even small houses have gardens, and allotments are not unknown. Some of the rather numerous blank pages might well have been utilized to indicate how much ecology can be learnt in gardening, and, indeed, must be learnt if the gardening is to be successful. W. B. T.

Fish who Answer the Telephone:
and other Studies in Experimental Biology. By Prof. Y. Frolov. Translated from the Russian by Stephen Graham. Pp. x+168+14 plates. (London: Kegan Paul and Co., Ltd., 1937.) 6*s.* net.

THIS chatty little volume should be welcomed by experimental biologists and will make fascinating reading for the layman who is at all interested in the experimental work now being prosecuted on animal behaviour.

The work of Pavlov is well known to all biologists —especially physiologists—and Prof. Frolov, who worked with Pavlov, has for many years pursued similar lines of investigation. Though this book (with a misleading main title, since it signifies the content of one chapter only) does not claim to give scientific detail of value to research workers, it makes interesting fireside reading for a biologist and gives him a good insight into the experimental method of Frolov and his school. Furthermore, many biologists, especially those beginning their careers, will learn much of academic interest; for example, that *Amphioxus* was discovered by Alexander Kovalevsky in an inlet on the Crimean shore, that the well-known Marine Biological Station at Naples was first of all suggested by the German biologist, Dohrn, and is actually the oldest of such stations, that Frolov himself was the first to claim to have demonstrated a sense of hearing in fish (though whether Prof. von Frisch would agree is an open question), and that much which has been written about instinct and behaviour in ants is the product more of imagination rather than of observation.

More mature psychologists and physiologists will be pleased to revive their memories of work on the behaviour of dogs, experiments on the behaviour of chickens even before they are hatched, and so forth.

Anyone opening the book will be unlikely to put it down until he has read it from cover to cover. Mr. Graham is to be congratulated on translating the work in a most pleasing style.

Geological Excursion Guide to the Assynt District of Sutherland
By Dr. M. Macgregor and Dr. J. Phemister. Pp. 62+4 plates. (Edinburgh: Edinburgh Geological Society, 1937.) 2*s.*

THANKS to the Edinburgh Geological Society, the visitor to the Assynt district of Sutherland is now well equipped. The authors give a carefully planned descriptive itinerary of a series of seven excursions to ground easily accessible from Inchnadamph. All the localities are capable of being visited and examined during a week's stay in the neighbourhood; shorter itineraries also are provided, indicating how to use to the best advantage periods of four, three and two days. The detailed excursion section of the guide is prefaced by a short but clear summary of the geology and structure.

The thoroughness of the authors is shown by the provision of a glossary of place-names, an index, blank pages for notes, and details regarding transport and accommodation. The details of the excursions have been carefully checked in the field, and are fully illustrated by four excellent colour-printed maps and three other sketch-maps in the text. The visitor may be confidently assured that with this guide in one pocket and the one-inch Geological Survey map of Assynt in another he will miss none of the main features of this fascinating district. He must not forget the map, for it contains important 'vertical' and 'horizontal' sections which make it an essential complement to the guide.

Enthusiasts will find that the excursions keep them fully occupied. Non-specialists, however, may think that the petrological picnics to Loch Borrolan (of borolanite fame) and Loch Ailsh might be replaced, in part at least, by an excursion of a more leisurely character to one of the places they have already visited; for they are sure to have fallen in love with at least one particular spot or view in such wonderful country. T. R.

Technical Electricity:
Principles and Practice. By J. E. Phillips and Dr. R. W. B. Stephens. Pp. vii+288. (London: The Technical Press, Ltd., 1937.) 7*s.* 6*d.*

THE great difficulty with students of electrical engineering in technical colleges is that they have very little training in physics, and several well-meaning text-books have been produced recently which try to instil fundamental magnetic and electric principles in the shortest possible time, and without making the student tired with difficult discussions about electro-magnetic units and the reason why one way of deducing our definitions of the intensities of fields and so on is preferable to another. There is always the outstanding difficulty why we use unit magnetic poles for definitions when no such pole exists; it is a difficulty which each teacher must solve for himself, before trying to train the immature mind to think in similar terms. The present authors succeed as well as some others, but perhaps tend to err on the more practical side. This is a good fault, however, since the type of student in view is best appealed to through his practical experience—sometimes more up to date than that of his teacher.
L. E. C. H.

Modern Management
By Prof. J. E. Walters. Pp. xiv+337. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1937.) 15*s.* net.

THIS book gives a reasonably comprehensive account of the methods of modern management and of the practical applications of the scientific method to various phases of management. It is emphatically not a book for the general reader; but if it contains rather too much detail for him, those who are concerned with particular problems of management may perhaps regret that its account of the Gantt Chart, the Bedaux system and similar matters is rather too condensed. On the whole, however, it is a well-balanced work, although the section on organization and its principles might with advantage have been expanded. Selected bibliographies are appended to each chapter, and these are reasonably representative, although relating in the main only to American publications.

Soil Erosion: the Growth of the Desert in Africa and Elsewhere*

By Sir Daniel Hall, K.C.B., F.R.S.

USUALLY the soil is regarded as something particularly stable, but this stability is almost wholly due to its normal covering of vegetation. There is always a danger that if the cover of vegetation is removed the soil itself will begin to move under the action of either the wind or the rain. Rarely do we see these actions at work on a large scale in England; the climatic conditions are not favourable, for our rainfall is gentle and evenly distributed throughout the year, and our big winds are mostly associated with rain. It is in semi-arid regions, where long periods of drought may be followed by torrential rains, that soil erosion becomes an active danger.

The earliest cases of erosion to be noticed are those which follow deforestation in regions where the mountains in which the rivers take their rise are below the permanent snow-line. In such countries, typically in the eastern Mediterranean—Calabria, Greece, the greater part of Asia Minor—the natural sequence is forest on the higher slopes where the rainfall is greatest, passing into upland meadows as the slope grows less and finally into river meadows as the river nears the sea. There is no evidence in support of the belief that forests increase the rainfall of a country; but they serve as its regulator. The spongy soil below the trees, rich in humus, absorbs the rain as it falls, whereby it reappears later in the springs and furnishes the watercourses and rivers when the rainy season has passed. But too commonly the forests have been cut down without any regard to their regeneration; not only has the maximum of timber been cut out but there has also been the desire to extend the grazing, and unfortunately in these Mediterranean countries goats are among the chief grazing animals. Hungry goats will eat anything that grows; they destroy every seedling tree as fast as it gets its head up, they complete and extend the destruction the woodcutters have begun. At the same time, with their sharp hooves they break the surface of the soil; in other places they tread hard paths down which the rain begins to run with gathering volume and velocity. In a very short time during the rains, gullies begin to form as the soil is washed downhill; year by year the gullies extend and bite deeper into the earth until in no long time—a generation or two—the hillsides that had been forest and upland meadow get bared down to the hard infertile subsoil or to the rock itself.

Nor does the damage end there; the rainfall running off the bared hill country without a check develops as a torrent lower down, attacking the meadows bordering its course. The earth also that has been washed off the hillsides is carried down to the plains where the rivers lose their velocity; there it is deposited and turns the river into a chain of malarious swamps, chokes its mouth and destroys any harbour that was there. Such has been the history of much of the fairest land on the seaboard of the Levant; on the heights, bare rock where once forest and meadow flourished, rivers that are torrents in winter and dry in summer, old seaports no longer accessible. The destruction of the forest was thus a major factor in the decay of Greece and of Rome itself; it meant in the first place the loss of farming land and of the agricultural population which formed the backbone of the early armies of the republics. With the swamps came the spread of malaria, which again has been invoked as one of the great causes of the fall of ancient civilization.

The most spectacular form of soil erosion is that exhibited by the vast dust-storms which, in 1934 and 1935 especially, swept over the United States east of the Mississippi. A vast area, which included western Oklahoma, western Kansas, eastern Colorado, the Panhandle of Texas and parts of Wyoming, has become known as the Dust Bowl. In 1934 it was estimated that on a single day 300 million tons of rich top soil were swept as far away as the Atlantic. There is a story that in the diary of an old Nebraska doctor was found the entry "June 14th. Hot as hell, wind 40 miles an hour, two Kansas farms go by every minute".

The causes of this terrible wind erosion are easy to discern. It arises only in comparatively arid districts where the rainfall is below the 20-inch level, and (in America in any event) where the fundamental subsoil is of a rather sandy type—a recent glacial drift. Before white settlement, these regions were clothed with grass and were the natural home of the buffalo. Some of the land was good grazing, with a fair depth of black soil rich in humus; in the drier parts the sod was thin and there were only a few inches of soil. The black soil regions were fertile and were the first to be broken up; the poorer land was kept for ranching, healthy for either cattle or sheep if not too closely

* From a Friday evening discourse delivered at the Royal Institution on November 12.

stocked. The plough, however, began to encroach upon these thin soils, with great rapidity when prices of cereals went soaring up from 1917 onwards. At first all went well, for the cultivation began in a cycle of good rainfall seasons and there was some stock both of humus in the soil and of accumulated rainfall below. Years of drought followed when the original subsoil reserve of water had been used up, and the light soil, no longer bound together either by vegetation or humus, began to drift in the fierce winds that sweep over those great plains. The plough has destroyed the binding power of the soil; the wind is then able to remove the whole of the fertile top layer of soil and leave nothing but the denser subsoil, which is too infertile to carry a crop. Nor has it been the case that the good soil is merely transferred from one farm to the next; as a rule in Canada it has been swept right away into the Great Lakes or the barren lands to the north, or even into the Atlantic itself.

Without doubt, much of the poorest of this land ought never to have been ploughed even in boom times; once the crust has been broken it becomes a sort of running sore always eating into the land on its margin. As a ranch under its natural vegetation it had a modest productive value, and to that use it must return.

In Canada, improved methods of cultivation have been introduced to minimize the danger of soil drifting. Since it is inevitable that at certain seasons of the year the soil should be cultivated while bare of a crop, the practice has been introduced of dividing the land into strips, the bare land alternating with land under crop in place of the former large areas under the same treatment. Thus the incipient soil erosion under the wind is checked before it can proceed far, and a very efficient measure of protection is attained.

One other major work of reconstruction is needed, though it is being taken in hand on a large scale in the United States, and that is the establishment of shelter belts to break up the fierce winds which rage over these open treeless spaces. It is not an easy matter to get trees started, especially the north in Saskatchewan and Alberta, where the range of species that will stand up to the extremes of climate is limited, but a certain number of suitable species have been found. Besides the original planting of cross-country belts, farmers are being taught to protect their own holdings.

Erosion by rain is even more common wherever the cultivated land lies on a slope and the rains are heavy. The danger does not lie in a large annual rainfall; some of the worst destruction is wrought in regions where a low total is concentrated into short intense spells.

As soon as the rate of fall becomes sufficient to cause an actual flow of water at any spot it acquires an excavating power and begins to cut a channel in the loose earth, a gulley which not only enlarges itself by the undercutting of its banks but also tends to eat its way backwards. Gulleying can be initiated either by careless management of cultivated soil or on grassland by overgrazing, which bares the surface. Even before actual overgrazing sets in, both cattle and sheep will tread bare tracks along which streams will begin to flow during the rains and to acquire sufficient velocity to eat into the soil. In however small a way such gulleying starts, if it is not checked it extends itself from season to season, until eventually, by a sort of geometrical progression, the large area may become impassable to man and beast. Though agriculture generally is indicted as the initiator of erosion, more properly it is the recklessness or the want of foresight in man that should be blamed. Erosion is like fire; a trivial accident may start it, and if not checked at once there may be no staying its progress.

In a recent book "Rich Land, Poor Land" is described a great crater in Georgia, 200 feet deep, that had arisen from a simple gully. "Do you know what started him? A trickle of water running off a farmer's barn 40 years ago. Just one dam little trickle, and now a third of the county's gone—forty thousand acres." An area in Tennessee ten miles in diameter has been gullied to desolation through destruction of the vegetation by the fumes of a copper smelter.

The loss of land is not all that the community suffers. The soil that the rain starts moving reaches the rivers and has to find a resting-place somewhere. It is in regions liable to erosion that irrigation becomes of so much importance, and dams are thrown across the rivers to store the flood-water of the rains. But no one had foreseen what masses of sand and silt would begin to choke the reservoirs when erosion was going on at the head waters. The Rio Perco is reported to be pouring every flood season 9,000 acre feet of silt into the lake built to supply New Mexico with its quota of water from the Rio Grande. The last Mississippi flood was the wildest and most dangerous of any in the history of the river, notwithstanding all the protective measures that have been carried out, simply because the lower river is being raised more and more above the level of the surrounding country.

A large amount of work is now being done in the United States to control gulleying and to reclaim the devastated land. In the early stages, gulleying can be checked by throwing dams across the gash, dams which may be timber or concrete or just bushes, alive or dead, anything that will

check the rush of water and cause the sediment to begin to accumulate. Even more effective has been the introduction of rapidly growing plants, which not only check the flow of water and filter out the silt but also bind the earth and stop further washing. The Soil Conservation Service in the United States is bringing into play all the resources of science and engineering to repair the damage which had been inflicted upon the land of the United States by hasty exploitation. I would instance again the Civilian Conservation Corps, that inspiration of President Roosevelt's, which in 1932, when the youth of America found no prospect of employment of any kind on leaving school or college, gathered some 300,000 of them for service and set them to work to clean up the countryside. They were turned on to fire-prevention work in the forests, to checking erosion, to road making and vermin destruction in the national parks, to various forms of reclamation and salvage work—the corps itself being the most magnificent piece of human salvage this generation has known. One cannot but think that it would be of value to the population of Britain if all our young men could be conscripted for six months of their life to carry out public work for the improvement of our countryside.

The examples of erosion so far considered are due to the unthinking exploitations of the soil by civilized men. Similar destruction of the land is, however, taking place in Africa, where the tribes have not arrived at a system of farming that conserves the fertility of the soil, but practise the more primitive form of 'shifting cultivation'. The cultivator is allotted a particular plot in the area of jungle or bush belonging to his clan; this he, or rather his wives, clears, perhaps burning off the timber before putting in his crop. In two or three years the soil begins to become exhausted or weeds become intractable, whereupon the plot is abandoned and a new piece is taken up. The abandoned plot is soon covered with the natural vegetation, and in the course of time, perhaps ten, perhaps thirty years, recovers sufficiently to be ready to take into cultivation again. Thus the tribe requires many times as large an acreage of land as is actually in cultivation at any one time, and if the tribe is increasing in numbers it will be eating pretty steadily into hitherto unoccupied grassland or forest.

One other feature is of importance. The Bantu tribes, who predominate in East Africa, attach the greatest value to livestock, particularly to cattle. Cattle represent wealth and position; they are intimately bound up in tribal custom with the marriage ceremonies—indeed they enjoy a definitely religious status. They are the essential consideration that has to be tendered for a wife. But they serve little or no economic purpose. They are not eaten except ceremonially, by many tribes they are not milked, they are not beasts of burden, neither is their dung used as manure. Sheep and goats are in the same category; they are less sacred and less valuable; their only economic product is their skins for clothing.

Consider the consequences: within this century British rule has maintained peace among the tribes, and with the cessation of raiding, numbers have been rising steadily. According to census returns, the native population in the Union of South Africa has doubled in the last fifty years; in Basutoland the estimated population multiplied fourfold between 1879 and 1921. In Kenya the annual rate of increase is estimated at about 1½ per cent, which means doubling the numbers in forty-six years, and similar estimates are made for the Nandi tribes in the Kavirondo and for the Uganda population.

The increase of human population has been accompanied by an even greater increase in the numbers of livestock, which in the old days had been effectively kept under by raiding. With these checks gone, the animal population has outgrown the means of sustenance, and even in some districts is destroying the vegetation in uncultivated areas which should be regenerating against their turn to be brought into cultivation. The Native Economic Commission of South Africa, reporting in 1932, stated: "With the exception of certain parts of Zululand and Pondoland every native area is overstocked", and estimates that between 1918 and 1930 cattle increased from 7 to 17 hundred thousand, and sheep from 2¼ to nearly 4 million. The Kenya Land Commission, reporting in 1933, wrote: "Probably about 1920 the main stock areas of the native reserves had attained their optimum carrying capacity, and although fully stocked, were not overstocked. Since then the cattle population has—roughly speaking—doubled itself". Again, of the Kamba reserve: "Mr. Scott Little estimates that the reserve contains 190,000 cattle with 57,000 calves, though he estimates its grazing capacity at no more than 60,000 head. There are also 260,000 goats and 150,000 sheep. A journey through the area east and south of Machakos reveals that over large stretches of hillsides vegetation has been almost wholly removed. The soil has been eroded down to the subsoil and its removal will continue at an ever-increasing rate. On less steep slopes and on better land vegetation still persists, and though the Wakamba are primarily a pastoral tribe, patches of cultivation are in evidence. But even there grazing has been so persistent that the ground is all beaten down into little stock paths and has become in turn open to erosion".

Mr. C. W. Hobley, giving evidence about Tanganyika, said: "The native occupier, if space permits, moves on, leaving exhausted soil and desert behind him". Prof. E. P. Stebbing has uttered strong warnings of the encroachment of the Sahara upon northern Nigeria, due to shifting cultivation and overstocking in the forest. Major Grogan put the matter brutally when he said before the Kenya Land Commission: "The African people have never established a symbiotic relationship with land. They are, in the strict scientific sense, parasites on the land, all of them", and in another place he speaks of flying over Central Africa and picking out the eroded areas by their colour.

These instances will suffice; over a large part of Africa—the eastern side from the Abyssinian frontier down to the Cape, Uganda and parts of Nigeria, everywhere indeed except in the tropical rain-forest of the western seaboard and interior—conditions are such as render erosion by washing a danger. Further, there is a native population practising a destructive form of agriculture and keeping a vast uneconomic head of stock, including the devastating goat in large numbers; they are eating rapidly into such forest areas as are left open. Small wonder that famine is never far away from some of the tribes, that the major political issue between native and white man is the cry for more land. Yet even if there were more land to give, the day of reckoning would only be deferred, the new land would only be eaten up in its turn; the native must either change his methods or limit his numbers. Indeed, the situation has even now gone so far that from time to time the Government has to import food to save a tribe from starvation.

It is but recently that the dangers of erosion in Africa have come to be realized. However, it is now evident that all the African colonies have become erosion conscious, as may be seen from Sir Frank Stockdale's report on his recent tour through Africa.

Much yet remains to be done before the arrears of years of misuse of the soil can be repaired and before the native population can be educated to systems of farming which will maintain the fertility of the land. Not only have drastic changes in native custom to be brought about, but also in many cases expenditure is called for which can scarcely be found within the limited resources of the particular colony.

The regeneration of wasted areas must begin with closing them for a time to grazing, so as to allow the return of natural vegetation; if the land has not been very badly denuded, recovery is rapid; but in places it may be necessary to introduce specially useful plants like the stoloniferous grasses so characteristic of South Africa. A certain amount of minor engineering is needed to check run-offs and dongas by dams or plantations. Measures to deal with the invading weeds like *Striga* in Central Africa or the *Chrysocoma* of the south are still lacking. At the same time cultivators, both natives and white settlers, are being taught the virtues of contour ploughing and planting, and of vegetation strips in cultivated land to break up run-off.

Such measures, however, do not touch the major cause of erosion—overstocking. Legislative action is necessary to compel a reduction in the head of stock. The drastic culling that is called for must be done by way of purchase, and since the animals which would first be drafted are practically valueless for food, one or more meat factories would be required to turn the carcasses into manure and then into successively better products as the quality of the culls improved. A reduction in the numbers of cattle or sheep to one half or so would not only relieve the pressure on the land but also would give the native owners some chance of improving quality both by selection and by better feeding, whereas at present numbers alone are valued. Education should also proceed to induce the natives to use cattle economically for milk or meat and for traction, or at least to sell them for food.

Even more fundamental must be the education of the natives to adopt a conservative system of farming—a rotation that would include leguminous crops and so help the native dietary as well as restore nitrogen to the soil. Compost-making is another method of maintaining fertility which is being taught to the natives. The African cannot increase, cannot even maintain, his present numbers unless he learns how to use his plot of land so that it will continuously produce food.

But it is difficult to speak temperately of the urgent need for effort in this direction on a large scale. Many of the tribes are on the verge of starvation, the desert is growing apace, and as the cropping or grazing area shrinks, the pressure upon it becomes greater, and destruction proceeds at a compound interest rate.

The responsibility for action lies not only on the Colonial Governments but also on the British Government itself. It has declared itself trustee for the native populations; it must save them from themselves. Other nations are demanding colonies in Africa as sources of raw materials and as openings for colonization, but as soon as one gets away from the few mineral areas African land affords little opportunity of exploitation, and will indeed only continue to exist productively if its overlords adopt and persist in a self-denying policy.

Cobalt and Copper in Ruminant Nutrition

By Hedley R. Marston, E. W. Lines, R. Grenfell Thomas and I. W. McDonald

Council for Scientific and Industrial Research (Australia), Nutrition Laboratory, University of Adelaide

As the successful use of supplements containing cobalt for the prevention of bush sickness in stock has given rise to a considerable amount of publicity in which the original source of information has been largely lost sight of, a brief résumé of the sequence of events that led to this application seems desirable.

The apparently essential nature of cobalt in the nutrition of ruminants was first suggested by a group of workers in the Council for Scientific and Industrial Research Nutrition Laboratory in the University of Adelaide, from experimental findings during the investigation of the etiology of 'coast disease', a malady which affects sheep confined in their grazing to the highly calcareous shell sand littoral of southern Australia. The dramatic response and rapid restoration observed to supervene when minute amounts of cobalt (1 mgm. a day as soluble salt) were administered to seriously affected animals was announced at the Australian and New Zealand Association for Advancement of Science during the January meeting in 1935, when the close resemblance that coast disease bore to stock ailments known in different parts of the world as bush sickness (New Zealand), enzootic marasmus (Western Australia), pine (Cheviots and Inner Hebrides), nakaturuitis (Kenya), and salt sickness (Florida), was again stressed. This address was published a few months later.

The appearance of symptoms of lethargy, progressive wasting and anæmia in ruminants confined to certain restricted areas, and their rapid alleviation if the affected flocks are changed to a different type of country, has been recognized for many years. The description in 1807 of pining, daizing or vinkish by the Ettrick shepherd, James Hogg, suggests that this malady results from a deficiency, for the ". . . distemper . . . affects sheep confined to some districts . . . but removing them to fine land cures them immediately". The symptoms he reported later (1831) are those commonly recognized in the diseases mentioned above. McGowan and Smith's study of the distribution of pine disease in areas derived from porphorytic rocks on the Scottish side of the Cheviots, and Grieg and Dyrerre's investigation of the lethargic wasting as it occurs among sheep grazing exclusively on the shell sand beaches of the Isle of Tiree, led to the recognition of its similarity to bush sickness.

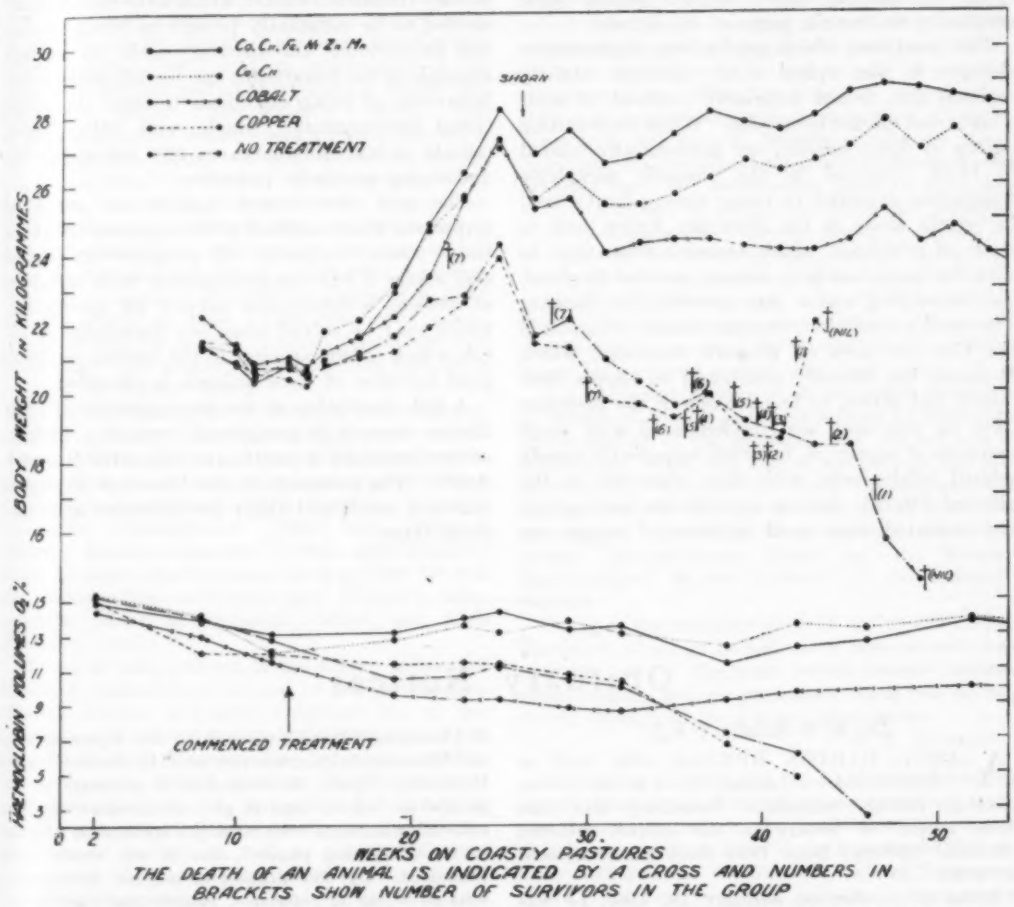
The New Zealand bush sickness, which occurs in areas usually defined by relatively recent volcanic showers, was referred to in the early reports of Park (1806) and later by Gilruth (1900). Guided by the hypothesis that the associated anæmia resulted from iron deficiency, Aston and his collaborators observed the benefit which followed dosing affected animals with massive amounts of iron salts, which, in the light of our present knowledge, it seems probable were contaminated with traces of other elements. For economic reasons, Aston suggested the use of the naturally occurring hydrated iron oxide, limonite, and this material, providing it originated from certain deposits, undoubtedly helped to control the disease.

The investigations of Filmer (1933) of a similar malady, enzootic marasmus, affecting both cattle and sheep grazed continually over certain highly ferruginous sandy loams of the Denmark district of Western Australia, led to the conclusion that while large doses of limonite prevented the occurrence of the malady and restored affected animals to normal health, pure iron salts were ineffective. Later, Filmer, in collaboration with Underwood, found hydrochloric acid extracts of limonite to be as active as the material itself, and the potency of these was unimpaired on removal of all but the faintest traces of iron. Underwood fractionated these extracts further ; but, owing to the vagaries of the chemical methods and his dependence on so-called pure chemicals, the issue was temporally obscured.

Meanwhile, the investigations of coast disease had proved that therapy with carefully purified iron salts, either alone or in conjunction with copper and with liver extract, failed to arrest the progress of the symptoms. The maintenance of health of sheep which had free access to a complex salt mixture containing cobalt while pastured on affected country was observed, and the publication of the production of polycythæmia in rats by minute amounts of cobalt by the Walthners, led to the experiments that resulted in the immediate response which cobalt therapy brought about in animals suffering from coast disease. The implication that sheep suffering from enzootic marasmus would react similarly to cobalt was amply confirmed by Underwood and Filmer's demonstration following a short visit of Dr. Underwood to the Nutrition Laboratory, Adelaide, that small doses of cobalt rapidly restored affected animals to normal health.

Reports of the variability of the response of bush sick animals to treatment with massive doses of limonite or of soluble iron salts led to the conclusion that Aston's iron deficiency hypothesis, although vigorously defended, was untenable. Rigg and Askew were unable to find a significant difference in the iron content of pastures from bush sick and healthy areas. They demonstrated later that iron-free extracts from healthy soils would completely prevent the onset of untoward symptoms in sheep grazing on bush sick country. Following the announcement of the effect which cobalt exerted on animals suffering from coast disease, Askew and Dixon (1936) demonstrated that cobalt supplements were completely effective as a preventive and cure of bush sickness as it occurs at Morton Mains, and since then the treatment has been widely applied with obvious success in New Zealand.

The part undoubtedly played by cobalt in restoring and maintaining health in sheep suffering from the three maladies, coast disease, bush sickness, and enzootic marasmus, which although strictly regional, occur in markedly different terrain, suggests that pine, nakaturuitis and salt sickness, which apparently evidence identical symptoms, may be the result of a breakdown in the chain of metabolic events for which cobalt provides a link; or not unlikely, they may indeed be of identical etiology, resulting from a metabolic disturbance


Co. Cu. Fe. Mn Zn. Mo
Co. Cu
COBALT
COPPER
NO TREATMENT
SHORN
BODY WEIGHT IN KILOGRAMMES
HAEMOGLOBIN VOLUMES %
COMMENCED TREATMENT
WEEKS ON COASTY PASTURES
THE DEATH OF AN ANIMAL IS INDICATED BY A CROSS AND NUMBERS IN BRACKETS SHOW NUMBER OF SURVIVORS IN THE GROUP

EFFECT OF COBALT AND COPPER ON YOUNG SHEEP DEPASTURED ON THE LITTORAL WHERE COAST DISEASE OCCURS. EACH MATCHED GROUP CONTAINS EIGHT LAMBS AGED 8 MONTHS AT BEGINNING OF THE EXPERIMENT. ALL WERE DEPASTURED TOGETHER, THE TREATED GROUPS RECEIVING THEIR SUPPLEMENTS IN AQUEOUS SOLUTION THREE TIMES WEEKLY. THE SYMPTOMS APPEAR AFTER ABOUT 20 WEEKS AND ACCOUNT FOR ALL WHICH DO NOT RECEIVE COBALT IN ABOUT 50 WEEKS. THE INCAPACITY OF COPPER WHEN ADMINISTERED ALONE TO PREVENT THE PROGRESS OF THE SYMPTOMS AND ITS EFFECT WHEN SUPERIMPOSED ON COBALT TREATMENT IS OBVIOUS.

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caused directly from a partial or absolute shortage of cobalt in the fodder of the affected areas.

Coast disease, in some regions, is a rather more complicated syndrome than that resulting from cobalt deficiency. While it shares the symptoms of lethargy, wasting and anæmia with the other maladies which respond to a small supplement of cobalt, sporadic outbreaks of ataxia are frequently observed in young lambs born of ewes which have spent a relatively short sojourn during their pregnancy on certain parts of the littoral.

This condition, which results from degenerative changes in the spinal cord, although strictly regional also, is not invariably confined to areas where coast disease is enzootic. While the resulting lesions of demyelination are anatomically related to those observed in the enzootic paraplegia (renguerra) reported to occur among lambs bred in certain areas in the Peruvian Andes, and to those of swayback, which accounts from time to time for many lambs in certain parts of England, the underlying cause may possibly be distinct. The similar condition, enzootic ataxia of lambs in the Gin Gin area of Western Australia, which Bennetts has recently attributed to copper deficiency and shown to be overcome if the pregnant ewes on this area are supplemented with small amounts of copper, is, however, apparently closely related etiologically with that observed on the affected littoral; for our experiments have amply demonstrated that small amounts of copper are essential to maintain cobalt-treated animals in good health while depastured on the areas where both ataxia and coast disease occur, notwithstanding the fact that supplementing with copper neither alleviates the symptoms of coast disease nor prevents the appearance of the anæmia and fatal decline if unaccompanied by cobalt.

The findings focus attention again on the possible physiological importance of those traces of elements, usually considered exotic, which have been demonstrated to be constantly present in living tissues, and furthermore, the discovery adds yet another example of the remarkable species difference in the behaviour of living organisms towards the nutritional environment; which, with little doubt, reflects subtle differences in the nature of the underlying metabolic processes.

The fact that horses exhibit no untoward symptoms when confined in their grazing to littoral tracts where ruminants will progressively decline and expire if left unsupplemented with cobalt is at present a fascinating subject for speculation, which may be solved when our knowledge of the role which cobalt assumes in the normal physiological function of some animals is extended.

A full description of the investigations of coast disease appears in monograph form in a Bulletin of the Council for Scientific and Industrial Research (1937). The references in the literature to similar maladies mentioned above are discussed in further detail there.

Obituary Notices

Dr. A. B. Rendle, F.R.S.

ALFRED BARTON RENDLE, who died at Leatherhead on January 11, was one of the leading British systematic botanists, and had been keeper of botany in the British Museum (Natural History) from 1906 until his retirement in 1930.

Born in London on January 19, 1865, he was educated at St. Olave's School, Southwark, and St. John's College, Cambridge, where he studied botany under Vines. In 1888, he was appointed assistant in the Department of Botany in the British Museum (Natural History), being placed in charge of the Monocotyledons and Apetalæ. It was characteristic of Rendle that his first taxonomic paper was not published until five years later, when he had mastered the technique of the subject. His work was consistently thorough, and the fact that he was able to accomplish so much is a tribute to his unremitting industry. As lecturer in botany at the Birkbeck Institute, Rendle kept in touch with academic circles, and in 1904 the first volume of his "Classification of Flowering Plants", comprising the Gymnosperms and Monocotyledons, was published by the Cambridge University Press. He described it modestly in the preface as "an attempt to give the student who has some acquaintance with botany a systematic account of the Flowering plants", but it was much more than this. By consultation of original memoirs as well as works of reference, Rendle had enriched it with many observations relating to embryology, anatomy, ecology, pollination and modes of fruit and seed dispersal, as well as with notes on the more outstanding types found in the various families. The second volume, including the Dicotyledons, appeared in 1925, and a new edition of vol. 1 in 1930.

Rendle fully appreciated the importance of the diffusion of scientific knowledge among the general public, and of closer relations between botanical theory and horticultural practice. He regularly attended the meetings of the British Association, and was president of Section K (Botany) at Newcastle in 1916. His knowledge of exotic floras and vegetation

was enlarged by visits to Canada, the United States, Australia, South Africa and Bermuda. For many years he lectured on botany at the Royal Horticultural Society, and he took a great interest in the work of local natural history societies, having been president of the South London Botanical Institute and chairman of the Botanical Section of the South-Eastern Union of Scientific Societies.

Among Rendle's more important early scientific publications were an enumeration of the Monocotyledons and Gymnosperms collected by Welwitsch in Angola (1899), a revision of the genus *Najas* (1899), an account of the family Najadaceæ for Engler's "Pflanzenreich" (1901), and an enumeration of the Gramineæ of China and adjacent areas in Forbes and Hemsley's "Index Floræ Sinensis" (1903). The families on which he worked most were the Gramineæ and Orchidaceæ, though the wide scope of his studies left him no leisure in which to do monographic work in either. A joint paper with William Fawcett on the Jamaican species of *Lepanthes* (1904) was followed by the production, in collaboration with Fawcett, of four volumes of their "Flora of Jamaica", the first of which, comprising the orchids, appeared in 1910 and the fourth in 1926. After Fawcett's death, Rendle completed a fifth volume (Rubiaceæ and Compositæ), the greater part of which had been prepared by Spencer Moore.

Among the wide range of subjects which engaged Rendle's attention were bibliography and nomenclature. His studies on the flora of Jamaica and the grasses led to the appearance of bibliographical notes on Swartz's "Prodromus" (1897), Steudel's "Synopsis Plantarum Glumacearum" (1899) and Browne's "Natural History of Jamaica" (1912). After Britten's death, he edited the *Journal of Botany* (1925–38) and the second edition of Britten and Boulger's "Biographical Index of Deceased British and Irish Botanists" (1931).

The world-wide interest in the thorny subject of botanical nomenclature aroused by the publications of Otto Kuntze and other reformers led to the formulation of various proposals for alteration of the Paris "Lois de la Nomenclature botanique" (1867). Those from the British Museum (Natural History) were communicated to the Vienna Congress (1905) by Rendle, who attended the meetings as delegate for the Linnean Society as well as for the Museum Department of Botany. He served as a member of the editorial committee of the International Rules of Botanical Nomenclature in 1905–1935, and was responsible for the English text of the third edition of the Rules.

Rendle became a fellow of the Linnean Society of London in 1888 and served for three periods on the Council before his election as secretary in 1916–23 and president in 1923–27. He regularly attended the Society's meetings, taking part in the discussions and contributing numerous papers to the *Journal* (*Botany*) and *Transactions*. He was elected a fellow of the Royal Society in 1909.

The keynote of Rendle's career was conscientious performance of duty. Whatever came to his hand, he did it.

T. A. S.

Prof. A. V. Martynov

ANDREI VASSILIEVITCH MARTYNOV, whose death occurred on January 28, was born in 1879 in Riazan, Central Russia. After graduating at the University of Moscow, he became an assistant professor in the University of Warsaw, then a zoologist in the Zoological Museum at the Academy of Sciences in Leningrad, and finally professor in the new Institute of Palæontology of the U.S.S.R. Academy of Sciences at Moscow.

The scientific work of Martynov in the earlier period was mainly concerned with the study of the systematics and zoogeography of Trichoptera (caddis-flies), in which group he was one of the leading experts and on which he published several first-class monographs and a very large number of papers. This work led him to broader studies in insect morphology, more particularly in investigations of wing venation from an evolutionary point of view, and in this direction he made most important contributions to entomological science. Later, he turned his attention to the study of fossil insects, again with brilliant results (see below). As an indication of his unusual ability and energy, it should be mentioned that he also found time to work on the systematics of the Crustacea (particularly Gammaridæ), on which group he produced several important works.

A characteristic feature of all taxonomic researches by Martynov was his persistent seeking for the better understanding of the problem, with the aid not of morphology alone, but also of the ecology and the distribution of the animals studied. For his researches he was awarded the degree of doctor of biological sciences by the U.S.S.R. Academy, while the Société Entomologique Belge and the Russian Entomological Society elected him an honorary member.

Owing to the extensive circle of his interests, Prof. Martynov, although he had never been abroad, was probably one of the most widely known Russian entomologists, and his premature death will be felt deeply throughout the entomological world.

B. P. UVAROV.

As a palæo-entomologist, A. V. Martynov had an international reputation. His palæontological work was devoted entirely to the fossil insect deposits of Russia, among which those of the Permian of Tikhiye Gory and those of the Jurassic beds of Turkestan (Kara Tau) deserve special mention. From these and many other localities, Martynov described, in about forty publications, a great number of new forms, many of them of considerable phylogenetic importance. In particular, it was his work on the Permian insects which made Martynov widely known and brought him into close contact with the late Dr. R. J. Tillyard, who worked on the Permian insects of Australia and of Kansas, and with Carpenter, who is investigating the Kansas fauna. Before Martynov's studies in fossil insects, almost nothing was known from Russian territory. Now, after his premature death, Russia occupies a prominent place in palæo-entomology, and this is entirely due to Martynov's energy. His qualifications as a

systematist appear in his careful descriptions, which will always retain their high value, even if in some cases his classification may have to be modified in future.

Martynov was able to trace backwards to earlier times the phylogeny of several groups of insects. He contributed a great deal to the knowledge of Permian Hemiptera, Mecoptera, Coleoptera, Odonata and other orders, and he described Phasmatodea and earwigs from Jurassic strata. The relations of these Permian and Jurassic forms to those of other countries were of special interest to him. He found close connexions between the Permian insects of Kansas and Russia, whilst the Jurassic fauna proved to be of an 'Angaran' type, with Indo-Australian relations.

There is no doubt that by Martynov's death palæo-entomology has suffered a severe loss and that his name and work will play an important part in research for a long time to come. F. E. ZEUNER.

Mr. D. Baxandall

MR. DAVID BAXANDALL, who recently retired from the position of deputy keeper at the Science Museum, passed away on January 10 at the age of sixty-three years, after a short illness.

Born on April 9, 1874, at Haworth, near Keighley, Mr. Baxandall received his early training at the Keighley Institute, where in 1891 he succeeded in winning a Royal Scholarship with which he proceeded to the Royal College of Science at South Kensington. Here he studied mechanics under Henrici and in 1894 obtained his first-class associateship in mechanics. He remained at the College for a further period during which he assisted Lockyer, until in 1898 he entered the Science Museum. During his first years at the Museum, he was employed in the Machinery and Inventions Division, but afterwards he was transferred to the Science Division, where he quickly developed a keen interest in early scientific instruments. He also studied the activities of early scientific instrument makers, and became a leading authority on this subject. Although Mr. Baxandall had a good knowledge of all kinds of scientific instruments, it was to astronomical, optical and mathematical instruments that he devoted his greatest attention, and it is chiefly due to his unremitting efforts that these subjects are so well represented in the Science Museum.

Mr. Baxandall was quiet and unassuming in manner, and although he was a fellow of the Royal Astronomical Society and of the Optical Society for many years, he was of such a retiring disposition that it was only with difficulty that he could be persuaded to speak at the meetings. He presented a number of papers on historical instruments and instrument makers before these Societies, and also contributed several articles to the "Encyclopædia Britannica".

By far the greater part of Baxandall's work, however, remains unpublished, for he collected together a large amount of valuable information on early instrument makers and their products, which he was hoping to prepare for publication, but unfortunately he was not able to complete the work. At the time of his retirement in 1934 he was deputy keeper in charge of the Science Division of the Science Museum, a position he had held for more than twelve years. He leaves a wife and two sons to mourn his loss, but he will be remembered with respect and affection by all who were privileged to know him as their friend.

Prof. Gustav Jäger

IN Gustav Jäger, whose death at seventy-three years of age occurred on January 21, Vienna has lost one of the last men who linked present-day physics with the classical period of the Viennese school as represented by the names of Stefan, Loschmidt and Boltzmann, and moreover one who had an unusually wide and all-round knowledge of physics. After several years of study in the laboratories of Stefan in Vienna and Helmholtz and Kundt in Berlin, he became assistant first to Stefan and later to Boltzmann. In 1905, he was appointed professor at the Technische Hochschule in Vienna, and then was called in 1918 to fill the chair of theoretical physics at the University of Vienna, which had formerly been held successively by Stefan, Boltzmann and Hasenöhrl. In 1920, Jäger changed this chair for the directorship of one of the University institutes of experimental physics. Generations of students have listened to his lecture courses, and greater still is the number of those who were introduced to the elements of mathematical physics through his "Theoretische Physik", published in the handy volumes of the "Sammlung Göschen", and distinguished by clarity as well as conciseness.

In his original contributions to physics, Jäger showed himself a true pupil of Loschmidt and Boltzmann by his life-long interest in the problems of the kinetic theory of matter. Best known among his papers are probably those devoted to the development of a kinetic theory of 'ideal liquids', analogous to that of 'ideal gases'. That his occupation with technical problems bore fruit is shown, for example, by his contributions to the theory of aircraft construction; he was one of the earliest men of science who defended, on theoretical grounds, the possibility of heavier-than-air flying machines.

Jäger retired from his chair of physics in 1934, but as a member of the Vienna Academy of Sciences remained to the last in touch with scientific matters. His death is deplored by a great number of friends and colleagues, who will miss his amiable and cultured personality and his sound and balanced judgment.

F. A. P.

WE regret to announce the following deaths:

Mr. Thomas Gann, known for his explorations in Central America and his investigations of Mayan archæology, on February 24, aged seventy years.

Dr. George Ellery Hale, For.Mem.R.S., honorary director of the Mount Wilson Observatory, Pasadena, California, on February 22, aged sixty-nine years.

News and Views

Prof. W. L. Bragg, O.B.E., F.R.S.

THE election of a successor to the late Lord Rutherford in the Cavendish chair of experimental physics in the University of Cambridge has been eagerly awaited by men of science all over the world, and it may safely be said that the appointment of Prof. William Lawrence Bragg, Director of the National Physical Laboratory, will give widespread satisfaction. Prof. Bragg shares with his father, Sir William Bragg, president of the Royal Society and director of the Royal Institution, the credit of founding the science of crystal structure which has grown in the last twenty-five years until it affects almost every branch of science, and dominates several. This work, a consequence of von Laue's discovery, was begun shortly after W. L. Bragg took his degree in 1912, and so rapid was the progress until the outbreak of the Great War that father and son were jointly awarded the Nobel Prize in Physics in 1915. During the War, Bragg made a great reputation as the leader and virtual creator of the British sound-ranging service which was generally admitted to have been consistently in advance of that of any other army. In this work, he showed both scientific and organizing abilities of the highest order, and led a group of men of whom many are famous in science to-day. Returning to Cambridge after the War, he was appointed in 1919 to succeed Rutherford in the Langworthy chair of physics in the University of Manchester, and proceeded to build up a school of workers with whose aid he disentangled crystal structures of ever-increasing complexity. His work on the silicates may be regarded as the culmination of this phase. Bragg possesses to a quite exceptional degree the power of thinking in the solid, and those who have worked under him speak with awe of his uncanny instinct for seeing the way in which a collection of atoms will group themselves.

IN recent years, Prof. Bragg has turned his attention to alloys, and by the application of the idea of co-operative action to the arrangement of atoms—the 'order-disorder' theory—has made important progress in this difficult, tangled subject. The study of atomic arrangements touches a surprising number of practical problems. Besides that of the invention of useful alloys, one may instance the agricultural properties of clays and recent developments in the study of proteins. It is possible, therefore, that under its new head the work of the Cavendish Laboratory may come into even closer contact with everyday life. It is only last year that Bragg was appointed director of the National Physical Laboratory (see NATURE, 139, 830; 1937), and it must have been difficult to face another change so soon; but the powers of organization and the personal qualities which made him so suitable a head for a large body of research workers will be of equal value at Cambridge. The Cavendish Laboratory is now so large that no one man can control it all closely, and Bragg's tact and gift of leadership form the best possible assurance of the happy co-operation of its many groups of research workers, while his brilliant lectures and personal charm ensure his success as a teacher of undergraduates.

Prof. G. M. Bennett

PROF. G. M. BENNETT, Firth professor of chemistry in the University of Sheffield, has been appointed University professor of chemistry in King's College, London. Prof. Bennett's researches have been of varied character. Some, such as those concerning the synthesis of penthiane derivatives, the nature of the polymeric ethylene sulphides and the derivatives of monothioethyleneglycol have dealt with subjects of particular interest in the chemistry of organic sulphur compounds. Among others of more general interest, his study of the stereoisomerism of di- and tri-sulphoxides is noteworthy; this revealed the existence of isomeric di-sulphoxides derived from substances such as ethylene disulphide, thianthrene and the others of dithioethyleneglycol, and it culminated in the isolation of the five oxides derived from trimethylenetrisulphide, an absolute proof of their stereochemical structures being obtained from their relationships. Another group of Prof. Bennett's researches has dealt with the variation in reactivity of a group under the influence of others present in the molecule. These began with a quantitative study of the influence of sulphur or oxygen on the reactivity of halogens or of the hydroxy group separated from the former by a lengthening chain of saturated carbon. The data then obtained and their theoretical interpretation led to experiments dealing with the general influence of nuclear halogens on aromatic side-chain reactivity; these led to the view that the electromeric effects of the halogens vary in intensity in an order which is opposite to that previously accepted. More recently, Prof. Bennett has made a study of organic molecular compounds and as a result has found justification for the view that in many of these the components are united by some form of a true valency bond. Adoption of this view led to the discovery that other electron-attracting groups such as cyanogen, methane sulphonyl, and chlorocarbonyl may serve instead of the usual nitro-group in one of the components.

Gustav Fritsch (1838–1927)

GUSTAV THEODOR FRITSCH, a pioneer in the physiology of the brain and one of the last great personalities of the classic period of German medicine, was born on March 5, 1838. He received his medical education at the Universities of Berlin, Breslau and Heidelberg under Helmholtz, Peters, Traube, Frerichs and Langenbeck among others, and qualified with a thesis on the central nervous system in 1862. He then spent three years in extensive foreign travel. In South Africa he made a study of the anatomy and physiology of the natives. He then visited Aden,

where he studied eclipses and passed on to Upper Egypt, where he made some important anthropological and ethnographical investigations. On his return to Germany he devoted himself to the study of diatoms and electric fishes, and in 1868 was made assistant to Prof. Reichert at the Berlin Anatomical Institute. His chief achievement was the discovery in 1870 in collaboration with Hitzig of the motor centres of the cerebral convex and their excitability by the faradic current, which formed one of the landmarks in the history of physiology. In 1908, at the age of seventy years, he published a remarkable work on the comparative racial morphology of the human retina, illustrated by plates prepared from photomicrographs, in which, as in scientific photography generally, he had always shown a keen interest. His death took place on June 12, 1927.

Native Policy in the Union of South Africa

THE arguments in favour of the transfer of the South African Protectorates to the Union of South Africa without further delay were stated ably and perspicuously by Mr. Lionel Curtis in his address to the Royal Empire Society on February 8. He pointed out that such a demand was inevitable on the formation of a National Government, which with its party is bound to consider how far the control it exercises in its domestic affairs, under the law as expressed in the Statute of Westminster, is effective. In such a survey, it is forced on their notice that the inhabitants of the Protectorates are dependent upon the Union territories for the sale of their produce and further a great proportion of them earn their living within the Union. Socially and economically the Protectorates, therefore, are integral parts of the Union. The relations of white to black lie at the root of all South African questions; and it is idle to tell the South African Government that it has been given complete control of its domestic interests so long as they lack control of areas, which, beyond dispute, are component parts of its social and economic community. Mr. Curtis then recited the changed conditions which have been brought about by the Balfour Memorandum and the Statute of Westminster, and argued that in view of that change it is no longer possible to meet the demand for transfer with the reply that it cannot take place until South Africa's native policy within the Union has conformed to British opinion. Not only is he not of the opinion that the interests of the natives throughout South Africa would be best served by withholding the transfer; but he also considers such a policy fraught with disaster. Noting the growth of a reaction against the prevailing opinion on native policy among young Afrikanders in the universities, he concluded by urging that the time is over-ripe for discussion of the transfer, consultation of the natives to form part of that discussion.

THE views expressed by Mr. Curtis have aroused no little criticism. This has served to indicate once more that there is a considerable body of opinion in Great Britain which attaches overwhelming importance to the obligation of the British Government to carry out its pledges—pledges both to the Union of South Africa, as well as to the natives of the South African Protectorates. No one has ventured to suggest that the transfer should be delayed indefinitely; but on the other hand, it is certain that instructed opinion would favour decisively the view expressed by Lord Lugard that some further delay is desirable. It is, however, no less essential that, if there is to be further delay, it should be secured by such means as will avoid hardening public opinion, which is steadily growing in South Africa against the tendency towards a more liberal policy in native affairs. The number of advocates of what may be termed, for brevity, 'the anthropological approach' is increasing, and the influence of the universities in leavening public opinion by the objective, non-political and scientific study of a difficult social problem is becoming stronger. In the long run, this leaven is bound to tell; and time is in its favour. In the last resort, however, the solution lies with the Union Government. When its native policy becomes such that it is acceptable, not as is suggested to opinion in Great Britain, but to the natives of the Protectorates, and wins, if not their assent, at least not their active and stubborn opposition, the time for transfer will have come. The acerbity of the argument in favour of immediate transfer put forward by some of its supporters argues a knowledge that reference to the native population at the moment would meet with an unfavourable reply.

Closing Excavations at Maiden Castle, Dorchester

THERE is a dramatic touch in the discoveries of the fourth and final season of joint excavation by the Society of Antiquaries of London and the Dorset Natural History and Archæological Society on Maiden Castle, which in other circumstances it would be difficult to accept as entirely fortuitous. Dr. R. E. Mortimer Wheeler, in describing his recent finds on this site before the Society of Antiquaries on February 23, was able to give a detailed account of the final assault on, and dismantling of, the fortress by the enraged troops of Vespasian in A.D. 43, which was not merely an imaginative reconstruction derived from topographical observation, but was also a direct inference from the evidence of such archæological finds as projectiles from the barrage of the field train of artillery, which preceded the attack, the ruins of the platforms or towers protecting the approaches, and the ashes of the burnt hutments outside the walls, in which were found the burials, hurried and confused as if interment had taken place in the night following the battle, of the defenders, whose bodies had been savagely hacked by the attacking soldiers. Then followed the evidence of the period of British occupation of the site as an open town, until the inhabitants were removed to the neighbouring Roman city, recently founded, where Dorchester now stands, and Maiden Castle was left waste, except for an isolated burial of a Saxon warrior in the seventh century, which brings the story of Maiden Castle to a close. Though less dramatic, two discoveries relating to the neolithic period are almost equally important as

confirming Maiden Castle's position as a classic reference in British prehistory. Of these, one was a crudely shaped chalk idol of the Mediterranean mother-goddess type, "an interesting and rare addition to the equipment of neolithic Britain"; and secondly a vast mound of later neolithic age, the largest of its kind as yet known, in one part of which was the skeleton of a young man with skull and long bones so hacked soon after death as to afford indubitable evidence of cannibalism.

Expedition to Northern Syria

MEMBERS of the joint expedition of the British Museum and the British School of Archæology in Iraq have left England for a fourth season of excavation on the archæological site of Tal Brak in north-east Syria. The expedition is in the charge of Mr. M. E. L. Mallowan, field director. He is accompanied by Colonel A. H. Burn, Mr. G. H. Bell, who is the architect of the expedition, and Mr. I. Threlfall. The excavations of previous seasons have shown that this site is especially remarkable for its evidence of early relations with Sumeria, and for its affinity with Hittite culture. This year the members of the expedition will continue the examination of a palace, which was laid out on an extensive scale under the dynasty of Sargon of Akkad about 2600 B.C. At the close of last season seven treasure chambers had been brought to light, but their examination had to be postponed as their condition was considered to be unsafe. Their investigation will now be resumed. The work of the expedition, however, will be directed more particularly to the remains of about the period 1500 B.C., when there was a considerable Hurrian population in the Khabur valley in close touch with both the cities on the Tigris to the east and with the Mediterranean coast to the west.

Twenty Years Progress in Science in the U.S.S.R.

THE twentieth anniversary of revolution is marked by the U.S.S.R. Academy of Sciences in the issue of special numbers of its periodical publications. The "Vestnik" of the Academy for October–November 1937 is a volume of 346 pages containing brief accounts of the work during the last twenty years of many, but not all, of the scientific institutes, museums and laboratories connected with the Academy. The number of such institutions has grown from 39 in 1917 to well over a hundred in 1937, with more than 4,000 on the scientific and technical staff as against 212. The October part of "Priroda" (published in January 1938) contains a series of brief surveys of twenty years progress in different branches of sciences, namely, mathematics, astronomy, physics, aerodynamics, chemistry, geology, petrography, botany, physiology, zoology (separate articles on ornithology, mammology, ichthyology, entomology, ecology), palæontology, etc. Many of the articles have a broader basis and treat in a concise form the Russian contributions to the progress of science not only during the 'Stalin's era', as the period 1917–1937 is somewhat inexactly termed in the leading article, but also in the years before the revolution. Indeed, the work of such veterans of Russian science as the astronomer Struve, physicist Lebedev, the great Mendeléeff, physiologist Vvedensky, zoologists Menzbier and Sushkin, etc., is given fullest credit, and it is shown how their ideas have been developed by their numerous pupils and followers in later years.

Official Tests of Composite Aircraft

THE combined seaplane *Mercury* and flying boat *Maia*, designed by Major Mayo and built by Messrs. Short Bros. of Rochester, mentioned in NATURE of February 19, p. 321, passed the first properly observed separation trial on February 23. The actual operation was photographed with a cine-camera from another flying boat flying parallel with it, and knowing the exposure times, accurate measurements of the rate and angles of separation can be made. Subsequent views on the film show that the parting was instantaneous and that the gap widened steadily enough to ensure safety under all reasonable air conditions. The test were not quite the most severe, as *Mercury* was not fully loaded with petrol, having only about half her capacity on board. This reduction of weight is necessary to allow a safe landing. Normally most of the fuel would be consumed during the flight, or in an emergency it can be jettisoned. During the take off, the control is entirely in the hands of the pilot of the lower component, the flying controls of the upper machine being locked by the same mechanism that attaches the two machines. When he wishes to separate, he informs the upper pilot by telephone, waits for an agreed number of seconds, and pulls a lever that releases both the upper machine and its controls. The lower flying boat is trimmed so that it automatically becomes nose heavy when released and dips away, while the upper seaplane, at its best climbing attitude, climbs rapidly. The separation took place at about 800 feet height, flying at 140 miles an hour. These figures could probably be increased considerably should bumpy conditions in the air demand it. It is understood that both pilots, Mr. Lankester Parker and Mr. H. L. Piper, considered the tests to be satisfactory.

Alchemy in Scotland

IN a lecture given on February 4 at Marischal College, Aberdeen, before the local sections of the Institute of Chemistry and the Society of Chemical Industry, Prof. John Read of the University of St. Andrews gave an account of alchemy in Scotland. James IV of Scotland appointed an Italian, John Damian, as his court alchemist, a laboratory being founded in Stirling Castle about 1500. Accounts of the Lord High Treasurer from 1501 until 1513 contain information about the costs of the materials used by Damian and his associates in their attempts to prepare the "quinta essentia", which ended when the King was killed at Flodden Field in 1513. Alexander Seton, who is said to have travelled from Scotland to the Continent in 1602 and to have performed a series of transmutations in various German towns, was tortured by the Elector of Saxony and was rescued by the Polish nobleman Michael Sendi-

vogius, but died in 1604 as a result of the cruel treatment he had received. Seton is said to have been the real author of the "Novum Lumen Chymicum", a work which was regarded as of the highest importance and was even treated with respect by Newton. John Napier, of Merchiston, the inventor of logarithms, was keenly interested in alchemy, as were his father and his son. William Davidson or Davisson, of Aberdeen (1593–1669 ?), was a chemist rather than an alchemist. He became physician to the King of France and wrote an early text-book of chemistry, "Philosophia Pyrotechnia seu Cursus Chymiatricus" (1633–5), which contains one of the earliest contributions to crystallography.

Acquisitions at the British Museum (Natural History)

PRESENTS to the Department of Zoology include the magnificent mounted head (the largest on record) of an Asiatic wapiti presented by Lieut.-Colonel Price Wood, and a very large mounted specimen of a Tasmanian platypus presented by Sir Frank Crisp. Among the specimens presented to the Department of Mineralogy is a fine set of minerals from Western Australia sent by Dr. E. S. Simpson. This includes remarkably large masses of petalite and its alteration products from a feldspar quarry at Londonderry, near Coolgardie. The petalite, a lithium-aluminium-silicate, occurs in masses weighing up to a hundredweight. This is the more remarkable as petalite is one of the rarer minerals and until quite recently was only known as comparatively small crystals. In 1935 and 1936, however, a quarry in pegmatite at Varaträsk, Boliden, northern Sweden, yielded many tons of the mineral, and individual crystals were found measuring more than a foot in length. A specimen of this petalite also was presented to the Museum by Prof. P. Quensel. Three fragments of meteoric iron presented by Mr. I. Reinvald, Inspector of Mines, Estonia, are of particular interest as they are part of a lot of about thirty pieces found after laborious search in the neighbourhood of the Lake of Kaalijärv in the island of Oesel. This lake was described in 1827 and many suggestions were made as to its origin. In 1929, Mr. Reinvald made a detailed survey and was convinced that the lake filled a meteorite crater. Five other smaller craters were found in the neighbourhood, but it was only in July 1937 that any meteoric iron was found to confirm the theory of their meteoritic origin. Other specimens received include rocks collected by Dr. J. V. Harrison, and Mr. M. H. Donald on excursions in the Urals and the Caucasus, following the International Geological Congress held in Moscow last year, and special mention should be made of a specimen of carved pyrophyllite from China, presented by Mr. B. Cattell, one of the warders in the Museum.

The Universities Bureau of the British Empire

FROM the Universities Bureau of the British Empire we have received the report of its executive council for 1936–37. Its membership, as at July 31, 1937, comprised the 19 universities of Great Britain and Ireland, 10 of the 21 Canadian universities, 3 of the 5 South African, 6 of the 17 Indian, the Universities of New Zealand, Malta, Hong-Kong and Rangoon, 6 university colleges and 4 other colleges. A resolution was passed by the Indian Inter-university Board last February to the effect that it was desirable that universities in India should join the Bureau. In addition to indicating briefly the various activities of the Bureau during the year, the report enumerates the subjects that were discussed by the Committee of Vice-Chancellors and Principals of the home universities, by the Australian Vice-Chancellor's Committee and by the Inter-university Board, India. The Bureau's Handbook for Students from Overseas published last year had a very wide circulation, and a new edition was prepared in collaboration with the British Council on British Teachers Abroad, which had prepared a somewhat similar manual relating to institutions other than universities. In the new edition, issued as a joint publication by the two bodies, the information has been amalgamated to form an outline of the facilities for higher education provided by universities and other institutions in Great Britain and Ireland.

Centenary of Le Officine Galileo, Florence

IN celebration and commemoration of their centenary, the house of Le Officine Galileo of Florence have issued a striking record of their past and present achievements in the sphere of the manufacture of scientific instruments and other high precision products. They pay tribute also to the men of distinction who have been associated with them and among whom they specially mention the late Marchese Marconi. It has been the privilege of this firm to introduce many instruments of epoch-making importance, and, before 1840, they constructed the circular dividing machine designed by and made to the instructions of Giovan Battista Amici. In 1878, they introduced the Caselli motor for torpedoes. In connexion with astronomical instruments theirs is a long and honourable record; in 1884 they constructed the astronomical clock in the Osservatorio Ximeniano in Florence, and have but recently completed the 1·20 metre telescope for the University of Padua—a model of which was shown at the Paris Exhibition. Among the early examples of their work illustrated in the commemorative volume are an electric automobile of 1900, a military goniometer, an electric field telegraph and the periscope for the Swedish submarine *Hajen* of 1902. An interesting contrast between the old and the new can be observed by comparing the illustrations of the theodolites—the spidery construction of the older type is in complete contradistinction to the compact rigidity of the model of to-day, which illustrates how design of fine measuring instruments has been influenced by the high degree of precision attainable in up-to-date manufacturing processes. Among the types of instruments now being manufactured are to be noted such diverse examples as microtomes, dermato-capillariscopes, stereo-cartographs, polarimeters, binoculars and projectors, while a separate list of electrical apparatus shows oscillographs, radio transmitters, measuring instruments, electric pumps and anti-aircraft equipments.

Radio Waves in the Upper Atmosphere

In a paper read to the Institution of Electrical Engineers on February 21 by J. P. M. Mellor, it is pointed out that pilot balloons sent up to record the electrical state of the atmosphere have failed as yet to detect any regions of particular interest to the radio engineer. Due chiefly to the increasing use of ultra-short waves for television, some six layers of ionized gas have now been discovered between 4 and 10 miles up. Each layer reflects the ultra-short waves under certain conditions. But they have no effect on the longer waves used in radio communication. Ultra-violet light from the sun ionizes the earth's outer atmosphere to different degrees at different heights; the ionosphere consists of free electrons and positive and negative ions in a rarefied gas. The *D* layer, between 40 and 60 miles above the earth, absorbs or attenuates radio waves. Above this, we have the region of maximum ionization, the Heaviside or *E* layer. Above the 120 mile mark, is the Appleton or *F* layer, which varies in height according to the time of the day. The portion of the energy radiated by the transmitter which travels over the surface of the earth is called the 'ground wave'. The magnetic field penetrates the ground causing eddy currents, thus frittering away the energy of the ray. Attenuation of the ground wave increases as the wave-length is decreased. The 'sky wave' is the wave which is propagated in the atmosphere above the earth. When it reaches an ionized layer, its path is bent earthwards when conditions are favourable. If its frequency is less than the critical frequency the wave is refracted, if equal to it absorption takes place and if greater than the wave it passes through the layer with very little attenuation. A wave sometimes arrives at the receiver after making a large number of ricochets between the ionosphere and the earth. If a receiver is situated close to the transmitter so that it picks up the ground wave and is in the area covered by the reflected wave, then since the waves have travelled different lengths they may interfere with one another and 'fading' will occur. 'Delay echoes' up to three seconds are readily explained by Störmer's electron envelope.

Consumption of Electricity by Wireless Receiving Sets

According to the *Beama Journal* of October, wireless, more than any other domestic appliance, familiarizes consumers with electricity and encourages them to become electricity consumers. Quoting from a report of M. Deutsch of Brussels, interesting figures relating to the electricity consumption of wireless sets in various countries are given. The B.B.C. returns the highest estimate, namely, an average annual consumption per set of 87 electric units for a wireless receiver, Belgium, France and Holland return 54 units and Germany 40. In the United States, the consumption per receiver is estimated to be 54. Since the number of mains-operated wireless receivers in the United States was 24 millions at the beginning of 1937, the total consumption due to wireless is therefore nearly 1,300 million units. In Great Britain the number of wireless licences issued at the end of August of this year was more than eight million. A few years ago it was considered that 100 sets per 1,000 inhabitants would be about the maximum. According to M. Deutsch, the existing figure in Great Britain is 160 sets per 1,000 inhabitants, Germany having 120 sets. To-day the maximum is reckoned to be about 300 sets per 1,000 inhabitants. Statistics for 1935–36 show large increases in the number of wireless sets sold in some of the more backward European countries. During this year, Bulgaria increased the number of receivers installed by 91 per cent, Rumania, Portugal, Spain and Poland all registered increases between 30 and 50 per cent. In Great Britain, the increase was 9·2 per cent, whilst in Turkey the figure declined by 10 per cent.

The Oxford Farming Conference

At the Oxford Farming Conference held on January 4–7 a number of interesting questions of fundamental importance were brought up, and the opening paper—the maintenance of fertility and the land fertility scheme—set the stage for discussions of a far-reaching nature. Although soil deterioration due to erosion or exhaustion of virgin land are not serious problems in England, much of the grassland is in a badly impoverished condition. Drainage, liming, application of phosphate and the sowing of wild white clover are the chief remedies, and the Government's Land Fertility Scheme should stimulate the efforts already being made in these directions. Grassland management, and its counterpart, grass conservation, were the subjects of a group of papers in which the different methods of making hay, silage and dried grass were discussed, from both the nutritive and economic aspects. Questions affecting the arable farmer also received attention, and alternate husbandry, on both light and heavy land, was advocated as being valuable for the increase of productivity, profit and employment, and for the control of animal disease and the promotion of national defence. Problems connected with plant disease were represented in a paper on soil conditions and the control of foot-rot in cereals, and the Conference concluded with a discussion on the ever-recurrent question of weed control.

New Varieties of Spring Oats

Particulars of two new varieties of spring oats that will be available for distribution for sowing this coming spring are given in Leaflet Series S. No. 4 (price 1*s*.) issued by the Welsh Plant Breeding Station, Aberystwyth, and farmers, co-operative societies and merchants desiring seed should make immediate application to the Station for supplies. Oats are grown over a wide range of soil and climate, and in the breeding work at Aberystwyth special attention is paid to the production of strains able to resist lodging and suitable to soils of varying productive capacity. The two new varieties, *S*. 84 and *S*. 175, are intended for soils of high and medium productive capacity respectively. For poor soils, the Ceirch

Llwyd Cwta (*S.* 171) is the more suitable variety, and useful information gained from practical experience in its cultivation during the previous season is to be found in the leaflet. Farmers growing the Aberystwyth strains are particularly requested to inform the Plant Breeding Station of the behaviour of the varieties in question, as such reports are of great value to those engaged on the selection work.

Conservation of Natural Resources

In the United States, strenuous efforts are being made by the Government, through its Forest Service, National Park Service, Soil Conservation Service, Tennessee Valley Authority and other agencies to remedy the disastrous effects of years of neglect and exploitation. Many voluntary organizations co-operate. In "Conservation in the Education Program" (*Bulletin* No. 4 of 1937), the Commissioner of Education presents an account of the progress made in introducing into school curricula instruction designed to awaken an appreciation of the importance to the community of conservation of natural resources and the duty of the individual citizen in relation thereto. Such instruction is conveyed in general in connexion with regularly established school subjects such as nature-study, elementary science, the social sciences, particularly geography; but in at least one State "Protection and Conservation of Life, Property and Natural Resources" is one of a number of social functions selected as bases for organizing instruction according to the theory that things should be learnt in relation to the ways in which they will be used. In addition to outlining existing practices, the bulletin contains a detailed prospectus prepared in the Curriculum Construction Laboratory of Teachers College, Columbia University, of a course of instruction on the theme "How is Man trying to Conserve his Natural Resources".

The History of Science

We have received vol. 3, part 1, of *Osiris*, the journal devoted to the history of science and edited by G. Sarton. This part is dedicated to Prof. E. O. von Lippmann, a biographical notice (with portrait) and a bibliography being contributed by J. R. Partington. Several of the articles deal with the history of mathematics and astronomy; there is also one on Sir Charles Blagden by F. H. Getman and one on Leeuwenhoek by A. W. Meyer, and L. B. Simpson contributes an account of the medicine of the Conquistadores based on a sixteenth century manuscript. The mathematical papers deal with linear and quadratic equations (Kloyda), the calculus of variations (Carathéodory), and the graphical representation of statistical data (Funkhouser). Other interesting papers make up a noteworthy issue.

Announcements

Sir John Anderson, the National Government candidate, has been elected Member of Parliament in the Scottish Universities seat which became vacant on the death of Mr. Ramsay MacDonald.

The Kelvin Medal Award Committee, on which are represented eight of the most important engineering institutions, has awarded the Kelvin Medal for 1938 to Sir J. J. Thomson, Master of Trinity College, Cambridge, in recognition of the eminent services he has rendered to engineering science. The presentation will be made by Lord Rayleigh at the Institution of Civil Engineers on May 3.

The first award of the James Alfred Ewing Medal of the Institution of Civil Engineers has been made to Mr. C. S. Franklin, research expert, formerly chief of the Independent Research Department, of the Marconi Company. Mr. Franklin is known chiefly for his researches in connexion with the Marconi beam system. The Bayliss Prize of the Institution has been awarded to Mr. R. Kerridge.

The following have been elected honorary members of the Institution of Civil Engineers: H.M. the King of the Belgians; H.R.H. the Crown Prince of Sweden; Sir Robert Elliott-Cooper, senior past-president of the Institution; and Sir Frank Smith, secretary of the Department of Scientific and Industrial Research.

Sir Albert Seward, formerly professor of botany in the University of Cambridge, has recently been elected a trustee of the British Museum.

Prof. E. S. Goodrich, Linacre professor of zoology and comparative anatomy in the University of Oxford, has been elected a member of the Section of Zoology of the Royal Swedish Academy of Science, Stockholm.

The twenty-ninth Congress of the German Radiological Society will be held on July 4–7 at Munich under the presidency of Dr. G. A. Weltz. Further information can be obtained from Prof. Karl Frik, Brückerallee 22, Berlin.

The fifth International Congress of Cell Research will be held at Zurich on August 7–13, when the following subjects will be discussed: epithelium in cultures and in the organism, structure of chromosomes, mechanism of mitosis, cancer cell and normal cell, experimental cell investigation, and investigation of viruses. Further information can be obtained from Das Anatomische Institut, Plattenstrasse 9, Zurich 7.

The annual Malaria Control Course for Laymen (engineers, planters, etc.) will be held at the Ross Institute of Tropical Hygiene commencing on June 27, 1938. The course will be under Sir Malcolm Watson, director of the Institute. It is designed for planters and mining engineers, but it will be of interest to all (including missionaries) who are proceeding to the tropics. Further information can be obtained from the Organizing Secretary, Ross Institute of Tropical Hygiene, Keppel Street (Gower Street), London, W.C.1.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

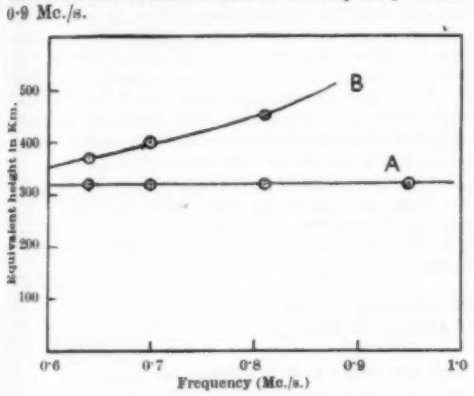
NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 417.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Magnetic Double Refraction of Medium Radio Waves in the Ionosphere

IN 1935, two of us[1] reported the results of experiments in which pulses were reflected from the ionosphere using a frequency less than the magneto-ionic gyro-frequency and in which the polarization of the echoes was determined by means of a "circularly polarized" receiving aerial. We found doubled echoes from region *F* on frequencies below about 1·0 Mc./s. and we showed that the echo of shorter delay had left-handed polarization and that of greater delay was right-handed. We therefore interpreted the two echoes as magneto-ionic components, and this interpretation was supported by observations of the change over of the reflection from region *F* to region *E*.

In further experiments of the type then reported, we have since investigated the way in which the echo doubling varies with frequency and have found that the separation between the two components increases as the frequency is increased as shown in the accompanying graph, which exhibits the results of measurements made at 0030 on December 14, 1935. We found that the right-handed echo *B* became weaker as the gyromagnetic frequency was approached, and we could not follow it above a frequency of about 0·9 Mc./s.



In a recent issue of NATURE, Martyn and Munro[2], who have conducted their experiments in the southern hemisphere, produced a graph very similar to that shown above, but have given quite a different interpretation of it. Since, however, in considering the results shown by our graph, we have now arrived at a more complete explanation on the lines of that previously given, it may be of interest to contrast the two interpretations.

Our own reading of the results exhibited in the accompanying graph is very simple. We consider that the curve *A* refers to the ordinary and *B* to the extraordinary ray echoes. Since we are dealing with a frequency f, which is less than the magnetic gyro-frequency f_H, the ordinary ray is reflected at a level in Region *F* where the electron concentration N is given by

$$N = \frac{\pi m}{e^2} f^2; \qquad (1)$$

while the extraordinary ray is reflected where N is greater, that is to say where

$$N = \frac{\pi m}{e^2}(f^2 + f f_H). \qquad (2)$$

Bajpai and Mathur[3] have shown that, for extraordinary waves of the frequency range we are considering, the group velocity is relatively low over most of their track in the ionized medium, so that these waves are delayed in time behind the ordinary waves. Delay occurs as a result of transmission both through regions E_1 and E_2 and through such part of region *F* as lies below the reflection level. This explanation agrees with the observed polarization of the waves. For frequencies approaching the gyro-frequency the absorption of the extraordinary wave echo is very considerable. This explains why it cannot be followed beyond about 0·9 Mc./sec.

The agreement of experiment and theory in the case of our experiments raises a difficulty in connexion with the Australian experiments, where the results to be explained are similar but are given a different interpretation. Martyn and Munro, for example, consider that both traces in their figure refer to ordinary waves, though no experimental check of similar polarization is mentioned. They accept, as we do, that the curve *A* represents the ordinary ray echo which is reflected at the level conditioned by equation (1); but they consider that curve *B* represents an echo due to waves which have penetrated the 'over-dense' stratum which lies between that level and a higher level where the ordinary ray refractive index becomes infinite. The value of N at this higher level is given by[4]

$$N = \frac{\pi m}{e^2} f^2 \left(\frac{f_H^2 - f^2}{f_H^2 \cos^2\theta - f^2} \right). \qquad (3)$$

(There appear to be slips in the formula given by Martyn and Munro). Now it is easy to show that this interpretation requires that, when f approaches $f_H \cos\theta$, the waves should 'leak' through a 'barrier' of approximately 100 km. or about 400 vacuum wave-lengths. The difficulty of an explanation along these lines need not be elaborated beyond this point.

To settle the matter an examination of the polarization of the echoes obtained in Australia is needed. If both components are found to be of the same polarization, the explanation given by Martyn and

Munro is acceptable. If, on the other hand, the two echo-components are observed, as in England, to be of opposite polarization, the explanation of the phenomenon given by Martyn and Munro must be abandoned together with the two further deductions they have made from it.

E. V. APPLETON.
Cavendish Laboratory, F. T. FARMER.
Cambridge. J. A. RATCLIFFE.
Feb. 2.

[1] Farmer and Ratcliffe, NATURE, 135, 831 (1935).
[2] Martyn and Munro, NATURE, 141, 159 (1938).
[3] Bajpai and Mathur, *Indian. J. Phys.*, 11, 165 (1937).
[4] Appleton, *Proc. Union Rad. Sci. Int.* (Washington, 1927).

Mean Free Path of Protons in the Universe

IT is known that on different occasions and in different forms a dimensionless constant of the order of between 10^{39} and 10^{40} recurs in physics—the variety being due to the fact that two other dimensionless combinations (hc/e^2 and mp/m_e) are *comparatively* small and, besides, are of the *same* order (10^3). Some of us believe that the *large* constant is the square root of the number of mass-units (protons and neutrons) in the world (N). I propose to name 'Eddington's relation' the relationship between universal constants which springs from this assumption. For it is essentially *one* and we need a name for it, in order to be able to say, this is essentially Eddington's relation, when we are presented with a disguised form of it.

Moreover, it is known that, from that assumption, if Einstein's relation between mean mass density and curvature is admitted, reasonable values result for the radius (R) of the universe and its mean density (ρ); following Eddington: $N = 1{\cdot}57 \times 10^{79}$, $R = 1{\cdot}23 \times 10^{27}$ cm., $\rho = 3{\cdot}32 \times 10^{-27}$ gm./cm.^{3}).

An interesting form of Eddington's relation occurred to me recently. The mean distance between the closely packed mass-units in the nuclei[1] is $\delta = 3 \times 10^{-13}$ cm. It is seen that

$$\frac{R}{\delta} = \frac{1{\cdot}23 \times 10^{27}}{3 \times 10^{-13}} = 0{\cdot}4 \times 10^{40} \sim \sqrt{N} \text{ very nearly.} \quad (1)$$

Now let us call it an 'encounter', when two mass-units approach each other within the distance δ; and let us calculate the average number of encounters (n) along a great circle, assuming that all the units are free and form a gas: then

$$n = \frac{2\pi R \,.\, \pi\delta^2}{2\pi^2 R^3} N = \frac{\delta^2}{R^2} N \sim 1. \quad (2)$$

Thus, with uniform distribution, the mean free path would equal the world's circumference. In other words, the number of protons and neutrons would be just on the border-line of making the universe 'opaque' for a radiation to which each of them presented an absorbing cross-section of $\pi\delta^2$. Or again, the sum of the cross-sections of the particles is roughly of the same order (one sixteenth) as the cross-section of the universe.

There ought to be something essential in these very simple statements—unless Eddington's idea that the mass-unit is connected with the radius, R, is entirely deceptive. For, of course, δ *must* be connected with the mass-unit, since it is so very near to

$$\frac{h}{m_p c} = 1{\cdot}32 \times 10^{-13} \text{ cm.}$$

It ought, by the way, to be remembered that, in adopting Eddington's numbers, we already tacitly admit that the luminous masses concentrated in the nebulæ constitute but a small fraction, about one thousandth, of the mass of the universe.

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[1] Bohr, N., and Kalckar, F., *Kgl. Danske Videnskabernes Selskab, Math.-Phys., Comm.*, 14, 10, p. 9 (1937).

Neon and Argon in the Earth's Crust

IN the atmosphere, atoms of argon are some 520 times as abundant as atoms of neon. Russell and Menzel[1] have emphasized that in celestial sources neon is much the more abundant. This they explain by the hypothesis that the atmosphere has lost most of its neon, which it could only do at the time of its birth, when the temperature was presumably very high.

From this point of view, it is of interest to examine the earth's crust for argon and neon. I find, in fact, that granite contains these gases, the quantity being of the order of 10^{-4} c.c. neon, and 4×10^{-4} c.c. argon per gram of granite. The argon atoms are thus only some 40 times as abundant as the neon, instead of 520 times as in the atmosphere. These figures are derived from the examination of four samples of granite from different localities. The gases are liberated by decomposing the granite with fused caustic potash. The experiments are difficult because of the risk of atmospheric contamination, but it is believed that this source of error has been avoided. That the ratio neon/argon is greater than for the atmosphere is readily verified. The excess of helium present in the crude rare gases must first be got rid of, and I have done this by allowing it to diffuse out through red-hot silica. The argon spectrum is then dominant, but the yellow line of neon is conspicuous in it, whereas this line is not visible in the neon-argon mixture obtained from the atmosphere. The relative richness in neon is thus verified at a single *coup d'oeil*, and the spectroscopic result can be made quantitative by comparison with made-up mixtures of argon and neon. This gives a check on the volume measurements made on the separated gases.

The present results seem favourable to the view that there has at some time been a loss of neon from the atmosphere. They will be published in detail later. The further question of the ratio of argon to nitrogen in rocks is under examination.

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[1] *Proc. Nat. Acad. Sci.*, 19, 997 (1933).

Electron-Multiplier for Measuring Ionization Currents

THE letter from Prof. Z. Bay[1] gave details of the application of electron-multipliers to the measurement of photons and electrons emitted *in vacuo*. Experiments on similar lines have been carried out in this laboratory with the object of using electron-multipliers for measuring small ionization currents due to any type of radiation.

The saturation current in an ionization chamber was arranged to control the potential and hence the

number of electrons emitted from the illuminated photo-electric cathode of the electron-multiplier. The emitted photo-electrons were then accelerated on to a series of secondary electron emitting stages consisting of fine mesh grids, sensitized for maximum secondary electron emission, and arranged as parallel disks inside a metal focusing cylinder. The initial photo-electron current was thus amplified by secondary electron emission and the output current measured on an ordinary microammeter.

In this manner currents of the order of 10^{-11} amp. have been amplified to currents of between 10^{-4} and 10^{-5} amp., while it is possible to detect currents of the order of 10^{-14} amp. Attempts are now being made to measure even smaller currents. The main difficulty to be overcome is, as mentioned by Prof. Bay, a reduction of the thermionic emission of electrons from the multiplying grids. As he has shown, this can be done by cooling the electron multiplier down to temperatures in the region of 120°–150° K. This, however, is considered rather an unpractical procedure for general use. Experiments are now being made with secondary electron emitting surfaces having high work functions and correspondingly low thermal electron emission coefficients.

The advantages of this system of amplification is its general stability, it being comparatively insensitive to changes in the working potentials, making the operation from A.C. mains quite practical. Also, it is unnecessary to use delicate galvanometers, very high resistances, or sensitive balancing circuits, as the output current is large enough to be measured on a microammeter or milliammeter.

On behalf of the governing body, I wish to thank Messrs. Baird Television, Ltd. for their willing co-operation in these experiments. A detailed report of this work is to be published at a later date.

W. H. RANN.

Radium Beam Therapy Research
at the Radium Institute,
London, W.1.
Feb. 15.

[1] NATURE, 141, 284 (Feb. 12, 1938).

Significance of Gravity Anomalies in Relation to the Viscosity of the Asthenosphere

SOME time ago I published an estimate of the mean viscosity of the earth's silicate mantle on the basis of the rate of post-Glacial uplift of the Fennoscandian region[1]. It has been suggested recently[2] that if that estimate is correct, areas of large negative gravity anomalies, such as that in the Gangetic trough in India, should be rising at an observable rate. It is the purpose of this communication to examine this question briefly.

In the paper referred to, it was shown that at the centre of a radially symmetrical depression in the surface of a highly viscous fluid, the displacement of the surface, $\zeta(0)$, and the vertical velocity at the surface, $V(0)$, are connected by the relation

$$\zeta(0) = \frac{2\sqrt{\pi}\,\eta\, b}{\rho\, g}\, V(0), \qquad (1)$$

where g is the acceleration of gravity, η and ρ are respectively the coefficient of viscosity and the density of the fluid, and b is a quantity determined by fitting the surface velocity as a function of the radius, r, to a function of the form

$$V(r) = V(0)\, e^{-b^2 r^2}. \qquad (2)$$

In other words, b may be regarded as the reciprocal of the effective radius of the depression. The quantities $\zeta(0)$, $V(0)$, and b were determined from data for the post-Glacial uplift of the Fennoscandian region given by Nansen[3], and the kinematic viscosity, η/ρ, was found from equation (1) to be of the order of 3×10^{21} cm.^{2} sec.$^{-1}$.

The Gangetic area of negative anomalies has the form of a long strip, hence instead of equation (1) it would be better in this case to use the equivalent expression for a long trough-like depression. This is

$$\zeta(0) = \frac{4\,\eta\, b}{\sqrt{\pi}\,\rho\, g}\, V(0). \qquad (3)$$

Equation (3) may be applied directly to the present problem by noting that the depression of the surface is equivalent to a negative load $\sigma = \zeta\,\rho\, g$ dynes per square centimetre. We then have for the velocity at the centre of a loaded strip,

$$V(0) = \frac{\sqrt{\pi}\,\sigma(0)}{4\,\eta\, b} \qquad (4)$$

where b^{-1} is now one half the effective width of the strip.

The greatest distance between the lines of zero anomaly in a direction perpendicular to the axis of the belt is approximately 400 km.; b^{-1} is then somewhat less than 200 km., and, by analogy with the example worked out in the paper referred to above[1], it should be about 3/4 of this, or 150 km. The defect of load at the centre is of the order of 4×10^8 dynes per square centimetre. If we take $\eta = 10^{23}$, equation (4) gives a rate of uplift at the centre of 8·4 metres per century. This figure should be somewhat reduced since the actual distribution of the load can be better approximated by some distribution intermediate between the linear trough assumed in deriving (3) and the circular depression assumed in deriving (1). The other quantities being equal, the velocity for the circular load is 0·636 times the velocity for the linear load. Thus we should multiply our result by some factor between 0·636 and unity, say 0·9. The indicated rate of uplift will then be somewhere in the neighbourhood of 7·6 metres per century.

Results of repetition of earlier surveys have been interpreted[4] as indicating a rate of uplift varying from zero about fifty miles north of Calcutta to six feet per century in the neighbourhood of Benares. It has also been suggested that sudden changes of level have taken place in connexion with earthquakes, so that the average rate over a period of many centuries might be comparable with that derived above. However, both the levelling results and the changes of level associated with the Bihar earthquake of 1934 have been questioned[5], so that it may be advisable to consider what modifications of the theoretical discussions would be required in case it were demonstrated conclusively that the rate of uplift is of a smaller order of magnitude. Two possibilities are open. (1) The value taken for the coefficient of viscosity may be very much too small. But if that is true, then some mechanism other than viscous flow must be devised to account for the observed rate of uplift in Fennoscandia and the fact that the area which has undergone uplift in post-Glacial time coincides with the area which had formerly been covered by an ice cap. (2) The crust may be strong enough to support a load of the magnitude indicated so that viscous yielding at depth does not enter into the question at all. In the

case of a load the span of which is many times the thickness of the crust, as it is in the case of a continental ice sheet, the crust itself might bend elastically while the weaker substratum was displaced by plastic flow. Thus it is not necessary to suppose that the load was great enough to cause stresses exceeding the strength of the crust; it would have to be great enough to exceed the strength at greater depths. On the other hand, a load the span of which is comparable with the thickness of the crust, such as we are dealing with here, could cause only a slight elastic deflection of the crust; hence appreciable plastic flow in the subtratum would take place only if the load were great enough to cause failure of the crust.

Jeffreys has shown[6] that if hydrostatic conditions are assumed below the crust, an uncompensated load implies a strength of the order of $2d/kh$, for a load having the form $d \cos kx$, where h is the thickness of the crust. This is $2dl/\pi h$ where l is one half the wavelength, that is, roughly the equivalent of b^{-1} in the present case. Our quantity $\sigma(0)$ should be identified with the total range of load, $2a$. The stress difference is then $\sigma(0)/\pi bh$. There is some uncertainty as to what value we should use for h in this expression. If we take it to be the Hayford depth of compensation, it is of the order of 100 km. On the other hand, it might conceivably be as small as the depth of the Mohorovičić discontinuity, which has a minimum depth of 25 km.[7] If we use the latter figure, we have a maximum stress difference of $7{\cdot}6 \times 10^8$ dynes per square centimetre. This is less than the strength of granite at the surface, and, considering the rapid increase of strength with pressure[8], it is far less than the strength which must prevail at depths of a few kilometres. It should not, therefore, be necessary to assume a viscosity greater than 10^{22} gm. cm.$^{-1}$ sec.$^{-1}$. In fact, if it should turn out that uplift actually is going on in the Gangetic trough, it would become a problem to explain why the crust should yield at all to stresses of this order.

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[1] Haskell, N. A., *Physics*, **6**, 265 (1935).
[2] Jeffreys, H., personal communication to J. A. Sharpe.
[3] Nansen, F., *Avhand. Norske Videnskaps Akad., Oslo*, Kl. 1, No. 12 (1928).
[4] Hunter, J. de Graaff, NATURE, **133**, 236 (1934).
[5] Burrard, Sidney, NATURE, **133**, 582 (1934). Cf. also Survey of India, Geodetic Report, 1936, pp. 93–97.
[6] Jeffreys, H., *Mon. Not. Roy. Ast. Soc.*, Geophys. Supp. **3** (1), 30 and **3** (2) 60 (1932).
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[8] Griggs, D. T., *J. Geol.*, **44**, 541 (1936).

Kepler, Newton and Bode

MR. J. MILLER'S observation[1] that the orbits of the satellites of Saturn are distributed about the primary in a manner similar to that of the planets about the sun, leads one to suspect that Newton's law of gravitation is only a particular case of a more general law. Bode's law can no longer be regarded as fortuitous. Kepler's relation between planetary distances and periods may only apply at the distances given by Bode's law. If this is so, Newton's inverse square law only applies at those same distances—distances for which the actual law of force gives stable orbits.

It seems possible to have a law of force, other than that of the inverse square, which will give all three laws of Kepler, Newton and Bode for the stable orbits. If we take the force for a circular orbit as

$$P = \mu^2 \varphi(\mu),$$

it can be shown that for a stable orbit

$$\frac{\mu\varphi^1(\mu)}{\varphi(\mu)}$$

must lie between 0 and 1. But

$$\varphi(\mu) = \frac{4\pi^2}{\mu^3} \cdot \frac{1}{T^2},$$

where T is the period. Hence

$$\frac{\mu\varphi^1(\mu)}{\varphi(\mu)} = -\mu\left(\frac{2}{T} \cdot \frac{dT}{d\mu} + \frac{3}{\mu}\right).$$

For this to be 1,

$$\frac{dT}{d\mu} = -\frac{2T}{\mu};$$

and for it to be 0,

$$\frac{dT}{d\mu} = -\frac{3T}{2\mu}.$$

These expressions correspond to the limits of the band of stability between which an orbit can lie. Since the second expression agrees with Kepler's observation, all the planets occupy orbits on the outer edges of the bands of stability. In these positions, $\varphi(\mu) =$ constant, that is, Newton's law. But this is not the only value for $\varphi(\mu)$ which will give Kepler's law for the planets. There may be many such values. For example, if

$$\varphi(\mu) = \cos^2\left(\frac{1}{\mu}\right),$$

then

$$\frac{\mu\varphi^1(\mu)}{\varphi(\mu)} = \frac{2}{\mu}\tan\left(\frac{1}{\mu}\right),$$

which is 0 whenever $\frac{1}{\mu} = r = n\pi$.

If a shape for $\varphi(\mu)$ can be found which will make $\frac{\mu\,\varphi^1(\mu)}{\varphi(\mu)} = 0$ when $\frac{1}{\mu} = 3 \times 2^{(n-2)} + 4$, n being 1, 2, 3, etc., then a law of force giving Kepler, Newton and Bode will have been discovered.

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Feb. 8.

[1] NATURE, **141**, 245 (Feb. 5, 1938).

Interatomic Distances of $FCCl_3$ and $FCBr_3$

IN some early work we measured the interatomic distances of different methane and silane halides by means of the electron diffraction method. We wish to give here distances between atoms of $FCCl_3$ and $FCBr_3$ measured by the same method. These substances have been prepared and purified by Prof. F. Swarts. We are much indebted to him for giving us the opportunity of measuring these substances.

The values obtained (in A.) are:

$FCCl_3$: Cl–Cl = 2·94 ± 0·03; Cl–F = 2·56 ± 0·04; C–F = 1·44 ± 0·04; C–Cl = 1·76 ± 0·02:

$FCBr_3$: Br–Br = 3·20 ± 0·03; Br–F = 2·70 ± 0·02; C–F = 1·44 ± 0·06; C–Br = 1·91 ± 0·04.

One of these substances, namely, $FCCl_3$, has already been measured by Brockway[1]. His values (in A.) are: Cl–Cl = 2·91 ± 0·03; Cl–F = 2·56 ± 0·04; F–C = 1·40 ± 0·04; C–Cl = 1·76 ± 0·02.

Thus they are very close to those found by us. The results show: (1) that the distance C–F remains very nearly constant in both compounds; (2) that the distance C–Cl shows the same value in all compounds containing $C–Cl_3$ with the exception of $C–Cl_4$; the same conclusion is valid for C–Br; (3) going from $FCCl_3$ to $FCBr_3$, the pyramid CX_3 expands with a factor 1·088. A factor 1·075 may be used in passing from $HCCl_3$ to $HCBr_3$, and also in passing from $HSiCl_3$ to $HSiBr_3$[2].

A more extended discussion of these data will be published elsewhere.

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[1] Brockway, L., *J. Phys. Chem.*, **41**, 2, 185 and **41**, 5, 747 (1937).
[2] de Hemptinne, M., and Wouters, J., NATURE, **138**, 884 (1936). Wouters, J., de Hemptinne, M., and Capron, P., *Ann. Soc. Scient. Brux.*, **57**, 25 (1937).

A New Type of Structure in the α-Copper-Zinc Alloys

CERTAIN banded structures seen in cast α-brass after annealing have been identified by several investigators as true twins. Recently we have made an observation which suggests that there may exist structures that appear to be twins, but that are not twins. The observations were made upon two large cast copper crystals joined at a natural boundary which lay almost perpendicular to the external surface of the sample. Into this bicrystal, zinc was diffused by exposing it to the vapour from α-brass turnings at a temperature of 775° C. The system was enclosed in an evacuated silica tube. Zinc penetrated to a uniform depth over the entire surface of the specimen and gave a layer of perhaps half a millimetre of yellow brass.

Upon examination of a cross-section of the bicrystal, it was found that the grain boundary of the copper crystals had been disturbed within the zone of zinc penetration. In some regions along the original boundary, local recrystallization had occurred; but in others a peculiar type of grain growth appeared with the complete absence of new crystal formation. In the latter case the two grains were seen to have grown into each other in long parallel finger-like bands, greatly resembling twins (see accompanying photomicrograph), and leaving a much lengthened boundary running back and forth in zig-zags nearly parallel to the external surface of the sample. The breadth of the fingers thus formed was irregular, but in general was seen to be least near the surface of the sample and greatest at the limit of the yellow brass zone, beyond which the original boundary remained undisturbed.

It was at first surmised that this remarkable structure might have resulted from the highly improbable occurrence of the two grains of the bicrystal in a mutually twinned relationship, with their orientations such that a twinning plane lay parallel to the external surface. This situation could conceivably permit the two crystals to grow into one another in long bands by the simple operation of twinning. By means of an X-ray determination of the orientations of the two crystals, it was shown that they did not bear a mutually twinned relationship. In fact, the nearest approach of octahedral planes (twinning planes) between the two crystals was eight degrees. The bands, therefore, are not twins, but simple projections of one crystal into the other.

In all probability this displacement of the grain boundary can be traced to a periodic crystal growth induced by the strains set up within successive layers of the copper by the expansion required to accommodate the inwardly diffusing zinc. Presumably, the direction of growth is a matter of chance in each successive step, for the projections are distributed about equally on the two sides of the original boundary. Upon the basis of this hypothesis, it is to be expected that the bands would be narrowest near the surface of the sample, because in that region the concentration gradient of the zinc would be the steepest.

To the foregoing observations it may be added that in the present studies recrystallization and grain growth resulting from diffusion have been observed adjacent to flat surfaces and at sharp corners, but not in samples having convex surfaces.

IRREGULAR BOUNDARY OF A COPPER BICRYSTAL IN THE ZONE OF ZINC PENETRATION. MAGNIFICATION 100. ETCHED WITH AMMONIA AND HYDROGEN PEROXIDE. NOTE: THE LONG BANDS NEAR THE SURFACE EXTEND BEYOND THE FIELD OF THE PICTURE. THE ISOLATED BANDS ARE BELIEVED TO BE SECTIONS OF TONGUES COMING FROM ABOVE OR BELOW THE PLANE OF THE PICTURE.

The banded structures have been found in a number of different samples. Whether or not its occurrence requires the existence of special orientation relationships between the participating crystals could not be determined from the few data at hand. Although it seems likely that the diffusion occurring during the homogenization of cast α-brass could establish conditions similar to those existing in the bicrystals, this structure has not yet been definitely identified by us in a polycrystalline brass. Some of the bands seen in technical homogenized α-brass may well be this structure!

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A. M. MONTGOMERY.

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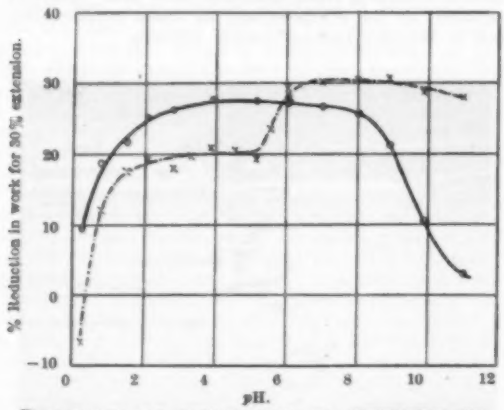
Constitution of the Keratin Molecule

DURING the past few years, much evidence has been accumulated in support of the view that the free acid and basic side-chains of wool are equivalent and form salt linkages between the peptide chains[1]. Although further proof of the salt linkage hypothesis may seem to be redundant in view of recent determinations of the amounts of aspartic and glutamic acids in wool[2], a proof based on the properties of deaminated fibres is essential to refute the erroneous conclusions drawn by Sookne and Harris[3] from a study of deaminated wool.

The resistance to extension of keratin fibres in acid and alkaline solutions is less than in water because of the breakdown of salt- and, above *p*H 10, sulphur-linkages between the peptide chains. A curve illustrating the reduction in the resistance of human hair fibres to extension in buffer solutions of varying *p*H, as compared with distilled water at *p*H 5·5, is given in the accompanying graph.



RESISTANCE OF HUMAN HAIR TO EXTENSION IN VARIOUS BUFFER SOLUTIONS; ○—○—○, UNTREATED; x—·—x—·—x·, DEAMINATED.

The undamaged root ends of human hair fibres were used in preference to wool because of the greater uniformity of the fibres, but the form of the curve, as well as the extent of the *p*H-stability region, are in conformity with the salt linkage hypothesis. When human hair fibres are deaminated, however, their resistance to extension should be sensibly independent of the acidity of the solution below *p*H 5, because there are then no salt linkages to be broken by acid. As the curve shows, within small limits, such is the case for single fibres deaminated by two treatments of 24 hours each in 40 c.c. of the van Slyke reagent at 22·2° C. in absence of air.

In terms of the salt linkage hypothesis, too, removal of the basic side-chains by deamination should free a corresponding number of acid side-chains for combination with alkali in the neighbourhood of *p*H 6. The fibre swelling thereby induced should reduce the resistance to extension, although to a relatively small extent because the reduction is due solely to swelling and not to breakdown of salt linkages. As shown in the graph, the resistance to extension decreases sharply between *p*H 5 and 7, in agreement with theory. Above *p*H 7, the resistance to extension is sensibly independent of *p*H until the sulphur bonds are attacked by alkali.

Thus the elastic properties of deaminated fibres are in strict agreement with the salt linkage hypothesis. The corresponding titration curve for deaminated human hair is now being determined.

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Jan. 24.

[1] Speakman and Hirst, *Trans. Far. Soc.*, **29**, 148 (1933); Speakman and Stott, *Trans. Far. Soc.*, **30**, 539 (1934); Speakman and Townend, *Trans. Far. Soc.*, **32**, 897 (1936); Speakman, *J. Soc. Dyers and Colourists*, **52**, 423 (1936); McMahon and Speakman, *Trans. Far. Soc.*, **33**, 844 (1937); Speakman and Townend, NATURE, **139**, 411 (1937).
[2] Speakman and Townend, NATURE, **139**, 411 (1937).
[3] *Bureau of Stand. J. Res.*, **19**, 535 (1937).

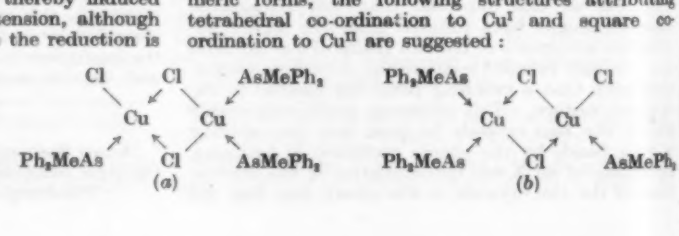
A Novel Type of Isomerism in a Co-ordination Compound of Copper

IF a warm alcoholic solution of cupric chloride is treated with diphenyl methyl arsine and allowed to stand overnight, two crystalline species (brown and blue) of identical composition $(Cu_2(Ph_2MeAs)_2Cl_3)$ are deposited. The separation of these two substances has already been described[1]. At that time the evidence put forward was insufficient to show whether the two compounds were really isomeric or not. Recently, however, it has been found that the two compounds are appreciably soluble in nitro-benzene, in which solvent the molecular weights of the two are of the same order (brown 878, blue 786). One form is therefore not a polymer of the other. Furthermore, these values, although somewhat lower than the theoretical (986), support the view that each form is binuclear.

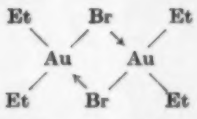
The brown form dissolves in thoroughly dried nitrobenzene to give a brown solution. This solution is quite stable at low temperatures and will deposit the brown crystals when cooled sufficiently; but if it is heated to 150° (or more) the brown colour will, during the course of half an hour, change to a greenish blue. The greenish blue solution will deposit crystals of the blue form on cooling. There is nothing to indicate that one form is a hydrate of the other. The fact that solutions of each form in the same solvent are differently coloured rules out the possibility of dimorphism. In confirmation of this it may be noted that the two forms behave differently towards ammonia and pyridine.

All the evidence available points to the conclusion that the two forms are isomers. Of the two, the brown form is the more stable. Even in the dry state the blue form has been found to revert to the brown over a period of several months. As would be expected, the transition of the blue to the brown form is more rapid in nitrobenzene solution. At room temperature, both forms are stable insofar as they show no tendency to lose the arsine even on long standing.

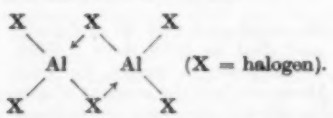
In order to account for the existence of two isomeric forms, the following structures attributing tetrahedral co-ordination to Cu^I and square co-ordination to Cu^{II} are suggested:



There is ample evidence from crystal structure analyses[2] that, in the bivalent state, copper is square co-ordinated, a finding which is also in accord with the results of Pauling's wave mechanical treatment of the question of bond orientation[3]. In both (*a*) and (*b*) therefore, all four bonds to Cu^{II} lie in the plane of the paper. On the other hand, univalent copper forms tetrahedral electron pair bonds as in Cu_2O, $K_3[Cu(CN)_4]$ and CuCl[4]. Thus the two bonds to Cu^{I} on the left of (*a*) and (*b*) lie one above and the other below the plane of the paper. If both Cu^{I} and Cu^{II} were tetrahedrally co-ordinated, there would be no possibility of isomerism, but with Cu^{II} square co-ordinated two isomers are possible as indicated in the proposed structures. Other instances in which two halogen atoms are considered as forming bridges between metallic atoms could be cited[5]. For example, diethylmonobromogold is believed[6] to have the following structure:



This is supported by crystal structure data for the compound. Further physical evidence that halogen atoms may function in this way is to be found in the results of electron diffraction investigations of the vapours of aluminium halides[7]. These indicate that the molecules have the structure:



(X = halogen).

So far, a study of the reactions of the isomers with pyridine, ethylenediamine and ammonia has provided no decisive evidence in favour of the structures. Work along these lines is, however, being continued and it is hoped later to test the structures by a physical method.

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[1] Burrows and Sanford, *J. and Proc. Roy. Soc. N.S.W.*, **69**, 182 (1935).
[2] Cox and Webster, *J. Chem. Soc.*, 713 (1935). Harker, *Z. Krist.*, **93**, 136 (1936); Robertson, *J. Chem. Soc.*, 615 (1935); Tunnel, Posnjak and Ksanda, *Z. Krist.*, **90**, 120 (1935).
[3] Private communication.
[4] Bragg, W. H., and Bragg, W. L., "X-Rays and Crystal Structure" (Bell and Sons, London, 1916), p. 155. Cox, Wardlaw and Webster, *J. Chem. Soc.*, 775 (1936). Wyckoff and Posnjak, *J. Amer. Chem. Soc.*, **44**, 30 (1922).
[5] Werner and Pfeiffer, "Anorganischen Chemie" (F. Vieweg and Sohn, Braunschweig), pp. 56 and 172. Bann and Purdie, *J. Chem. Soc.*, 873 (1936).
[6] Burawoy, Gibson, Hampson and Powell, *J. Chem. Soc.*, 1690 (1937).
[7] Palmer and Elliott, unpublished work: Gates and Crellin Laboratories of Chemistry.

Electrophoretic Behaviour in Nucleic Acid-Protein Mixtures

SOME noteworthy observations have been made in the course of an investigation of the electrophoretic properties of pure thymonucleic acid and mixtures of it with electrophoretically purified seralbumin. The technique employed has been described by Tiselius[1]. The results as regards the electrical mobilities and the mutual interactions between the nucleic acid and the protein will be presented elsewhere in the near future. Here it may be of interest to point out the remarkable behaviour of the serum pigment.

The seralbumin as usual contained a yellowish pigment (bilirubin, etc.) which could not be separated from protein even after repeated electrophoresis at *p*H values ranging from 4·12 to 8·00 (cf. also Bennhold[2] and Pedersen and Waldenström[3]). When, however, the albumin was electrophorized in the presence of nucleic acid, it was observed that the pigment changed 'carrier' and migrated with the nucleic acid. On the negative side, a completely *colourless* albumin remained behind.

An experiment with urobilin showed that this substance alone had a very slight mobility (*p*H 4·9), but when mixed with nucleic acid it migrated at the same high velocity as the latter.

Recently a similar 'carrier shift' has been observed by Ågren and Hammarsten[4], who were able to purify carboxypolypeptidase preparations from tryptic activity by means of electrophoresis in the presence of protamin.

A related phenomenon of pigment displacement has been emphasized by Bennhold[2] in discussions on the *Vehikel Funktion* of the plasma proteins.

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[1] Tiselius, A., *Biochem. J.*, **31**, 313 (1937).
[2] Bennhold, H., *Ergebn. d. Kinderheilk.*, **42**, 311 (1932).
[3] Pedersen, K. O., and Waldenström, J., *Z. physiol. Chemie*, **245**, 152 (1936).
[4] Ågren, G., and Hammarsten, E., *J. Physiol.*, **90**, 330 (1937).

Blood Group Inheritance

J. Ffoulkes Edwards and Dr. I. M. H. Etherington[1] have continued the discussion initiated by R. Elsdon Dew[2], who quoted J. S. de Goldfiem's[3] figures for the blood group distribution among the French Soussoux. Of these, 89 per cent belong to Group *AB*, and Edwards and Etherington explain this obvious anomaly by re-advancing their quadruple allelomorph theory of group inheritance. This appears to be entirely unnecessary, nor does their theory fit the figures observed elsewhere, and before enlarging on this hypothesis, it seems pertinent to inquire whether there really are 89 per cent of the population in this group. In the original investigation, Vincent's whole blood technique of grouping was used, which is notorious for its high percentage of false results due to pseudo-agglutination. It would appear far more probable that the error lies in the technique adopted —either in the failure to differentiate between pseudo- and true iso-agglutination, or in a bacterial pan-agglutination from infection of the test sera—than that Bernstein's triple allelomorph theory of inheritance, which fits so well all the known figures, should be at fault.

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[1] NATURE, **141**, 246 (Feb. 5, 1938).
[2] NATURE, **140**, 1066 (Dec. 18, 1937).
[3] *C.R. Soc. Biol.*, **123**, 391 (1936).

Separation of Flavin and Phosphorylated Flavin

Greene and Black[1] have found that phenol, the cresols, aniline and benzyl-alcohol are suitable for the extraction of free flavin from water.

Using a solution of phosphorylated flavin (purified liver extract), I found that phenol also rapidly took up phosphorylated flavin from water.

It appeared, however, that practically no phosphorylated flavin was extracted by benzyl-alcohol when a solution of phosphorylated flavin in water was shaken with an equal volume of benzyl-alcohol (*p*H values from 5 to 7·4 and salt concentrations from 0·5 to 4·5 per cent NaCl). Under these conditions one benzyl-alcohol extraction removed 76–79 per cent of free flavin from water. Other aromatic alcohols (phenylethanol, phenylpropanol and phenylethylmethylethylcarbinol also permitted a separation.

Details and applications by these methods of separation (for example, urinary excretion) will be published elsewhere.

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[1] *J. Amer. Chem. Soc.*, **59**, 1820 (1937).

Biological Effects of Deuteron-Deuteron-Neutrons

THE biological effects of neutrons produced by a cyclotron have been reported by Lawrence and others. However, neutrons generated by a cyclotron, using beryllium targets, are accompanied by a great deal of γ-radiation, and the effect cannot be attributed entirely to neutrons. The purest neutrons ever known are D-D-neutrons, which are produced by bombarding 'heavy' ice (D_2O) with deuterons accelerated by high voltage, that is, by the reaction of

$$_1D^2 + {}_1D^2 \rightarrow {}_2He^3 + {}_0n^1.$$

Since June 1937, through the kindness of the Nishikawa Laboratory of the Institute of Physical and Chemical Research, Tokyo, I have been examining

Fig. 1.
IRRADIATED THYMUS.

the biological effects on young rats of irradiating them with D-D-neutrons. As the maximum range of recoil protons generated by neutrons is great, we have made a special ionization chamber with aluminium walls 2 mm. thick, lined with a 0·2 mm. layer of paraffin, and filled with methane gas, in order to measure the total ionization. By comparison with a known quantity of γ-rays from radium, we measured the intensity of neutrons, and the result showed that, at 250 kv. and 20 μA., the ionization at 3·5 cm. from the source was equal to 1·3 r/hour. The following observations were made by irradiating young rats of about 20 gm. body weight with 10–30 r of D-D-neutrons.

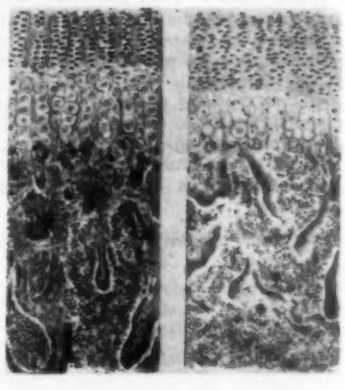

Fig. 2.
BONE AND BONE MARROW BEFORE (LEFT) AND AFTER (RIGHT) IRRADIATION.

The rats, irradiated with 30 r, did not increase in weight, and died in 5–10 days. With 26 r, rats showed no increase in weight for more than two weeks. About one half the amount of neutrons above-mentioned allowed the rats to increase slightly in weight after a week, but they were still very poor in growth, even after four weeks. After irradiation with 12 r, the total leucocytes decreased to about one half, that is, 3,600–4,800. This state continued with or without further irradiation. The most conspicuous was the decrease of lymphocytes, which decreased from 70–80 per cent to 20–40 per cent, and their absolute number was so low as 1000 or less after two weeks. Neutrophil leucocytes, on the other hand, increased from 12–20 per cent to 40–77 per cent, and their absolute number also increased. Monocytes increased for a time, but afterward decreased, and eosinophil leucocytes gradually decreased and finally disappeared. Red cells and hæmoglobin gradually decreased, nucleated red cells appearing in the circulating blood in many cases.

At necropsy, anæmia of every organ was marked. Spleen, testis, ovary, thymus, bone, etc., were especially decreased considerably in size. Microscopically, the lymph follicles of the spleen were found to be most quickly affected, where destruction or decrease of lymphoid cells could be seen. Following this, the degeneration of megacaryocytes in pulp came about. Two weeks after exposure to 26–30 r, we found practically no lymphoid cells in the lymph follicles, reticulum cells remained withered in thread-like form, and infiltration of polymorphonuclear leucocytes appeared. Megacaryocytes in pulp having almost gone, many small round myeloid cells with positive oxidase reaction appeared. There were also hæmosiderosis and erythrophagia. Four weeks after, many megacaryocytes appeared, also many myeloid cells, showing bloomy myeloid metaplasia, but the regeneration of lymph follicles was still unsatisfactory.

In the bone marrow, decrease of myeloid cells could be seen immediately after irradiation. Two weeks after the irradiation with about 30 r, bone marrow cells became very scarce, and blood vessels much enlarged. Most of the myeloid cells were very small, as seen in the pulp of spleen, and megacaryocytes, normoblastes, etc., were scarce. Four weeks after, various myeloid cells increased very much, and vigorous hæmatopoiesis was observed. The irradiated lymph nodes showed destruction or decrease of lymphocytes at an early stage, and two weeks after irradiation with 30 r, lymphocytes were entirely gone, and marked infiltration of polymorphonuclear leucocytes appeared. Four weeks after, islands of myeloid metaplasia came out, but lymphoid cells did not yet appear. In the thymus also degeneration and decrease of lymphocytes were conspicuous (Fig. 1). Epitheloid cells also degenerated and became fewer as a whole. Medulla was more affected than was cortex. As to the bone, we found in enchondral ossification at the epiphysis of the femur, four or five days after irradiation, degeneration and derangement in the cells of proliferating, hypertrophic and carcificating zones. Cartilaginous processes decreased in number and became thin. The injury to osteoblasts was still greater, and the growth of bone cells was very poor (Fig. 2); in consequence the greater part of the bone remained in the state of primary ossification. In the testis no spermatozoa were seen, our rats being immature, but spermatids, spermatocytes and spermatogonia were degenerated or decreased in number in most irradiated animals, Sertoli's cells and interstitial cells, however, showing no marked change.

As to other organs, the hypophysis showed degeneration chiefly in the eosinophil cells of the anterior lobe; pineal, for the most part, degeneration of epitheloid cells: adrenals, marked decrease of cortical fat, and degeneration in zona glomerulosa, where alone was seen lipoid deposits (Sudan III positive); liver, peripheral fatty degeneration in some cases; and kidney, irregular lipoid deposits (Sudan III positive) in the principal division of urinary tubule.

I wish to express my thanks to Prof. S. Nishikawa, Dr. H. Yamakawa and Dr. M. Miwa for their kind advice and interest in this work.

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Dec. 23.

Points from Foregoing Letters

A GRAPH showing that the separation of the two components of the radio waves reflected from region *F* of the ionosphere increases with the frequency, is submitted by Prof. E. V. Appleton, Dr. F. T. Farmer and J. A. Ratcliffe. The new findings, the authors point out, agree with their view that the two components are differently polarized, but cannot be readily explained on the supposition of Martyn and Munro who, from their experiments in Australia, deduced that both components are normal, but one penetrates into an 'over-dense' stratum. The writers calculate that on this hypothesis the waves would have to 'leak' through a barrier of approximately 100 km. or about 400 vacuum wave-lengths—an unlikely occurrence.

Prof. E. Schrödinger proposes the name 'Eddington's constant' for the large dimensionless constant, of the order 10^{39} or 10^{40}, which recurs in physics and is believed by some to be the square root of the number of mass-units (protons and neutrons) in the universe. Assuming uniform distribution, Prof. Schrödinger calculates the mean free path of the particles to equal the circumference of the universe and the sum of their cross-sections to be about one sixteenth the cross-section of the universe.

Lord Rayleigh finds that granite contains neon and argon, the relative amount of the former being some 13 times as great as in the atmosphere. This affords some confirmation of the suggestion by Russell and Menzel that the atmosphere has lost most of the neon that it formerly contained.

An 'electron-multiplier' similar to that recently described by Prof. Z. Bay, has also been constructed by Dr. W. H. Rann, who states that it has enabled him to detect currents of the order of 10^{-14} amp. and to amplify currents of 10^{-12} amp. to 10^{-6} or 10^{-5} amp. so that they can be measured on a microammeter or milliammeter.

N. A. Haskell calculates that the land in the trough of the Ganges would rise at the rate of about 7·6 metres per century, owing to the 'negative gravity' effect, if the viscosity of the underlying 'asthenosphere' has a value agreeing with that deduced from the rate of post-Glacial uplift of the Finnish-Scandinavian region.

If the orbits of planets and of satellites about their primaries are specified by Bode's law, then, Prof. G. W. Todd suggests, the laws of Kepler and Newton are only special cases of a more general law of gravitation.

Prof. F. N. Rhines and A. M. Montgomery find that a banded microstructure produced at the junction of two copper crystals into which zinc vapour had diffused, though looking very much like twinning, is not in fact due to twin crystals, but seems to have arisen through the growth of long, parallel, fingerlike bands from one crystal into the other.

Curves showing the reduction in the resistance to extension of human hair fibres (normal and deaminated) in buffer solutions of different acidity and alkalinity are given by Dr. J. B. Speakman and E. Stott. The authors state that the observed behaviour supports the salt-linkage theory for the constitution of the keratin molecule.

The preparation of two crystalline addition compounds, one brown and the other blue, of cupric chloride and diphenyl methyl arsine ($Cu_3(Ph_2MeAs)_2Cl_6$) is described by D. P. Mellor, G. J. Burrows and B. S. Morris. The authors consider that these represent a novel type of isomerism.

E. Stenhagen and Dr. T. Teorell report that when thymonucleic acid is added to a solution of seral-bumin containing a yellow pigment (bilirubin, etc.)—from which it cannot normally be separated—and an electric current is passed, the pigment changes its 'carrier' and migrates with the nucleic acid.

Benzyl alcohol may be used to separate flavin from phosphorylated flavin, according to A. Emmerie, since it extracts the flavin but not the phosphorylated compound, from aqueous solutions.

Research Items

Neolithic Settlements in Danubian Yugoslavia

RECENT archæological reconnaissance by the American Expedition to Yugoslavia in the Yugoslav portion of the lower Danubian Valley, that is, on the right bank from the Iron Gate to the mouth of the Timok, the left bank being Rumanian, has resulted in fresh data from a score of sites, of which five are extensive settlements with rich neolithic deposits. The investigation of these sites, situated in a region of which the prehistory is at present incompletely understood, has been described and the results analysed by Mr. Vladimir J. Fewkes (*Proc. Amer. Phil. Soc.*, **78**, 2; 1978). Observation is facilitated by the fact that the settlements, being situated along the bank of the river, have suffered much from erosion, which has exposed vertical profiles of the deposits. Systematic excavation on an extended scale, however, is an urgent necessity. Recent reconnoitring has established fresh evidence of neolithic occupation consisting of deposits *in situ* revealing dwelling pits as well as floors, and secondarily placed material, both related and unrelated to the settlement deposits. Additional data of later periods, of Bronze Age, La Téne and Early Slavic date, have been found. The material of neolithic age is characteristic of the Danubian Valley at large, including the barbotine pottery, which is widely distributed in the Danubian region. This pottery provides material for comparison and chronological study. Locally it is associated with the initial occupation, to which belong the lowest deposits characterized by pit-dwellings only. These show no traces of posts, which occur only with the later remains of dwellings with packed floors and without sub-pits, where the characteristic pottery is no longer barbotine, but incised, fluted, burnished and hand-smoothed wares. The neolithic evidence is invariably clearly intrusive.

Effect of Heptylaldehyde on Spontaneous Mouse Tumours

Two years ago, L. C. Strong, working at Yale University, showed (*Amer. J. Cancer*, **28**, 550; 1936) that the addition of a few drops of oil of wintergreen to the diet of mice with spontaneous mammary carcinomata produced a striking change in the tumours. They became dark owing to hæmorrhage, and this was followed by a connective tissue reaction throughout the tumour which led to a slowing of growth and a partial regression. Some of the regressing tumours, when examined on autopsy, were nothing but cystic masses containing fluid. Oil of wintergreen consists of methylsalicylate, but a repetition of these experiments with synthetic methylsalicylate failed to reproduce the results. This indicated that the effects observed with oil of wintergreen were due to an impurity. In a recent issue of *Science* (Feb. 11, 1938, p. 144), Dr. Strong records the fact that he has been able to identify this impurity as heptylaldehyde. The addition of a small amount of this substance to the diet of mice bearing spontaneous mammary tumours produced results even more striking than those observed after giving oil of wintergreen, namely, liquefaction and regression of the tumour. Out of 25 mice with spontaneous mammary tumours, complete regression occurred in five mice. Dr. Strong concludes his brief communication by stating that "his investigation opens up the question that spontaneous tumours, in mice at least, may eventually be controlled by chemotherapy". The comment may be permitted that mammary carcinomata in mice are particularly liable to spontaneous hæmorrhages and that the effect of heptylaldehyde may be to intensify this tendency. Further experiments on other types of animal tumours will therefore be awaited with great interest.

Noses and Genes

THE human nose shows variety of form in the individuals of the same family as well as stabilized differences in various races of mankind. C. B. Davenport tested the hypothesis that this variation was due to the development of noses along different lines, by measuring the growth-rates of various parts of the noses of babies and older children over a period of five to twelve years (*Proc. Amer. Phil. Soc.*, 78, 61; 1937). The results show that in the case of children with unlike noses the course of development is different, but even where no indication is given at birth the nasal proportions may be quite altered by excessive growth of a particular dimension. The author interprets his findings in terms of genes: "the development of the nose is under the influence of genes, but the active genes differ at different stages in ontogeny quantitatively (in functional output) or qualitatively due to the activity of new genes like those that determine the activity of endocrine glands. Where the total gene complex is the same, as in identical twins, the result is practical identity of nose form". It is not easy to see just what addition to the facts of the analysis of form is made by this hypothetical linking of noses with genes.

Habits of Migrant Birds in Winter Quarters

IN a detailed account of migrant birds in Tanganyika Territory, R. E. Moreau discusses briefly the ecology of some British summer immigrants during their absence from Great Britain (*Tanganyika Notes and Records*, Dar es Salaam, Oct. 1937). In general, the type of territory selected for winter quarters bears a similarity to the summer habitat; swamp-dwelling birds in swamp vegetation, grey wagtails on mountain torrents, blackcaps and garden-warblers in the edges of evergreen forest, nightingales in closed bush, wheat-ears on bare soil or eroded land. Practically all the others, from willow-warblers to kestrels, favour savannah or thorn-bush. It seems likely also that certain of the birds made definite climatic preferences; the author thinks that blackcaps, garden-warblers, and swallows winter only in highland country, usually above 4,000 feet, with maximum temperatures not exceeding 86° F. (30° C.). All the immigrants to Tanganyika encounter the hot season, but, according to district, they may live in the long rains or in a period which includes a dry spell in January and February. With these climatic differences are

associated differences in the abundance of the insect food upon which the vast majority of the immigrants subsist; and the fluctuations of food supply make the wintering birds less a stationary population than a collection of wandering individuals. It is interesting that the garden-warbler, which in Great Britain feeds mainly upon insects, although it occasionally takes soft fruits and berries, in Tanganyika depends largely upon small berries and, apart from the birds of prey, is the only migrant to live upon a non-insectivorous diet.

Feeding Mechanism of Lepidoptera

THE actual mode of functioning of the proboscis of butterflies and moths has long needed proper study, and various suggestions have been offered as to how the organ is manipulated. Mr. J. B. Schmitt, of the New Jersey Agricultural Experiment Station, contributes a paper on this subject which forms No. 4 of vol. 97 (1938) of the Smithsonian Miscellaneous Collections. According to this observer, the coiled proboscis of Lepidoptera is extended by means of blood pressure exerted in the stipites of the maxillæ. The pressure is brought about by the action of three pairs of muscles which, by their contraction, compress the stipites against the cranial wall. Two pairs of these muscles have their origins on the anterior arms of the tentorium while the third pair arises from the gena. By the action of these muscles, the blood becomes forced from the stipites into the cavity of each component of the proboscis, which thus becomes extended in front of the head. The coiling up of the proboscis in its characteristic manner is brought about by the relaxation of the pressure alluded to and by the contraction of diagonal muscles which cross the cavity of each component half of the proboscis. That blood pressure might be the agency for extending the proboscis has been suggested by Snodgrass who, in his "Principles of Insect Morphology", points out the mechanical analogy of the organ with the toy paper snake which a child unscils by blowing into it. The food liquids are imbibed through the channel of the proboscis by means of a kind of sucking pump derived from the pharynx, buccal cavity and cibarium—a conclusion which is evidenced by the relationships of the muscles concerned. The details and variations in different families of the musculature of the proboscis and sucking pump are described for a number of different familes. The paper concludes with a short account of the labium and its muscles.

Studies of Brackish-water Fishes from Madras

MR. S. JONES in his paper "Observations on the Breeding Habits and Development of certain Brackish Water Fishes of Adyar, Madras" (*Proc. Indian Acad. Sci.*, 5, No. 6; 1937) gives very interesting notes on several fishes, the investigations being part of a scheme proposed for the study of the brackish water fauna of the Adyar River. Parental care has been noticed in *Etroplus suratensis*, *E. maculatus*, *Acentrogobius neilli*, *A. viridipunctatus* and *Petrocirtes bhattacharyæ*. The eggs of the two species of *Etroplus maculatus* are laid on stones or shells, the young emerging from them having cement glands on the head by means of which they fix themselves head downwards into small pits dug by the parents, which place them there after hatching. The feeding habits of the 'mud-skipper' *Boleophthalmus boddoerti* (Pallas) are described. This fish, contrary to the usual idea that it is predaceous, eats only micro-organisms, chiefly diatoms, but occasionally copepods. *Aplocheilus melanostigma* and *Panchax parvus*, on the other hand, are well known as insect larvicides. These two exercise no parental care, although the eggs in *Panchax* adhere by mucus to the ventral side of the mother.

Timber of *Eucalyptus astringens*

A FURTHER paper has now been published on the properties of Australian timbers (Pt. 2. Brown Mallet (*Eucalyptus astringens*) by I. Langlands. Div. For. Prod. Tech. Paper No. 23, Melbourne, 1937). It is stated that brown mallet has in the past been solely exploited for its bark, which is one of the richest in tan among the raw materials used in the tanning industry. It has suffered from reckless exploitation, to replace which the Western Australian Forestry Department commenced extensive plantations in 1929. The timber had not been used to any extent. The tests dealt with in this pamphlet appear to indicate that the species has outstanding mechanical and physical properties. It has comparatively small shrinkage, is almost the equal of American hickory in toughness, and is said to excel that species in static strength, though less resilient. It is considered, therefore, that it should prove a good substitute for the American timber save for the most exacting purposes.

Solanums immune to Potato Blight

POTATO growers in the plains of India are dependent upon supplies of 'seed' from Assam and the foothills of the Himalayas, in the same way that English growers rely upon Scotland, Ireland, and parts of Wales for the provision of vigorous stocks. The lowlands of India are not usually visited by the late-blight fungus *Phytophthora infestans*, but the crops upon the higher ground are often prone to its depredations. Such infestations curtail production, but have the even more serious effect of diminishing the seed potato supply to the plains. Messrs. B. B. Mundkur, B. T. Pal and Pushkar Nath have investigated the disease (*Ind. J. Agr. Sci.*, 7 (4), 627–637, Aug. 1937) with the view of controlling it by the propagation of resistant or immune host plants. Useful degrees of resistance have been found in several Indian, European and South American varieties of *Solanum tuberosum*, whilst the species *S. demissum*, *S. neoantipoviczii*, with its variety *Reddickii*, and *S. antipoviczii* were immune from the disease. They should therefore provide a promising parentage for the introduction of immunity into stocks of the potato by crossing.

Bibliography of Seismology

WITH the simultaneous issue of the last two quarterly numbers, Dr. E. A. Hodgson completes his valuable list of more than five hundred memoirs on earthquakes and allied subjects during the year 1937 (Pub. Dominion Observatory, Ottawa). As might be expected in a work so extensive, the titles as a rule are alone given, but occasionally, as in the case of Miss E. F. Bellamy's "Index Catalogue of Epicentres for 1913–1930", a useful, if brief, account is added. Lists of notes appearing in various journals, such as NATURE, *Science*, the *Engineering News-Record*, etc., are given. A welcome addition to last year's list is Mr. D. C. Bradford's bibliography

of microseisms, containing the titles of 120 memoirs, the forerunner, it is to be hoped, of many similar lists. The volume ends with a subject-index, under more than fifty headings, of the year's memoirs.

Synthetic Motor Spirit Production

POLITICAL reasons continue to foster interest in methods of synthetic motor spirit production, particularly in those countries where underground petroleum resources are lacking. Low-temperature carbonization and destructive hydrogenation processes have been brought into considerable prominence during the past few years, and a great deal of time and money have been expended on their improvement. Recently a third process, known as the Fischer-Tropsch process, has begun to attract the attention of technologists, financiers and politicians alike. H. G. Shatwell, in a paper presented to the Institute of Fuel on December 7, laid particular emphasis on this somewhat revolutionary method. The origin of this process was a discovery by Fischer and Tropsch some fifteen years ago that if water gas, freed from sulphur, is passed over an alkali-iron catalyst at 450° C. and a pressure of 150 atmospheres, an oily product is formed which is known as 'Synthol'. By cracking, this can be converted into hydrocarbons known as 'Synthene'. Later, it was discovered that the oxygen content of the product could be eliminated by operating in the presence of hydrogenating catalysts at low temperatures and pressures. Improvements in technique followed as a result of detailed laboratory and large-scale research, with the result that several plants are now in process of erection on the Continent. It remains to be seen how it will compare with other processes of synthetic motor-spirit production from a financial point of view.

Reactions in Gaseous and Solid Mixtures

IN accordance with the arrangements made between the Anglo-Batavian Society and the University of London, a lecture entitled "Reactions in Gaseous and Solid Mixtures" was delivered by Prof. W. P. Jorissen of the University of Leyden at the Imperial College of Science and Technology on February 21. Prof. Jorissen dealt with the limiting mixtures capable of propagating reaction in gaseous mixtures of two, three or more components and also in solid mixtures of several components. He illustrated how the behaviour of such systems could be exhibited by triangular diagrams; the different types of diagrams for the limit mixtures obtained in gaseous systems are also representative of many of the systems of solid reacting substances investigated. Similarity, for example, was shown by the diagrams illustrating the behaviour of hydrogen, chlorine, and nitric oxide mixtures with those of the systems ammonium dichromate, sulphur and iron, and the effect of nitrogen and of silica respectively on such systems. Similar relationships hold for the velocity of propagation of reaction in gaseous and in solid mixtures. In some cases, an enclosed elliptical region of reaction is obtained, in others hyperbolic curves bound the regions. Prof. Jorissen deduced from le Chatelier's equation relating to the combustion of limit mixtures that such behaviour would be expected. Among the many observations which form the experimental basis for the formulation of the behaviour of the systems investigated, may be mentioned the influence of small quantities of isoamyl bromide, 1·5 per cent of which is sufficient to prevent the combustion of methane-air mixtures under the conditions of these experiments; on the other hand, at certain concentrations, propyl bromide tended to induce oxidation of such mixtures.

Diffraction Effects due to Axial Obstructions in Telescopes

MR. H. E. DALL has published an important paper with the above title (*J. Brit. Astro. Assoc.*, **48**, 4, February 1938), in which he gives the results of his investigations on the obstruction of central rays by the prism or small mirror in the case of reflecting telescopes. He constructed artificial stars and artificial planets, making use of a low-voltage lamp for this purpose, and experimented with four types of diffracting apertures. These were as follows: that with no central obstruction, and three with central obstructions one fifth, one third, and one half the diameter of the reflector, respectively. The second and third are commonly employed for reflecting telescopes, half-diameter obstructions being rather rare. Mr. Dall supplies a considerable number of photographs for various cases, and these bring out very clearly the changes in diffraction rings, spurious disks, etc. When the central obstruction does not exceed one fifth the diameter of the aperture, there is no serious loss of detail contrasts; but in the case of close unequal double stars there is some loss of visibility. When the obstruction exceeds the above amount there is a noticeable falling off in crispness of detail, and in addition, there is an increase in spurious detail and diffraction haloes.

The Masses in Single-Spectrum Binary Systems

PROF. H. C. PLUMMER has recently published a paper with the above title (*Mon. Not. Roy. Astro. Soc.*, **98**, 2; December 1937), in which he objects to the view expressed by Dr. R. G. Aitken in "The Binary Stars". Dr. Aitken states that the function $m_1^3 \sin^3 i/(m+m_1)^2$ is frequently omitted by the computors of orbits because it gives very little definite information. Prof. Plummer is convinced that valuable information bearing on the masses of the systems can be derived in the work of obtaining orbits from single-spectrum stars, and carries out a very full investigation of the problem in his paper. The mass function determined from a single spectrum binary can be regarded as a function of $m\sin^3 i$ and the mass ratio $f = m_1/m$. It is assumed in the investigation that, within a limited range of spectral type, the mass of a star tends closely to a typical value, and no distinction is drawn between giants and dwarfs. While the adopted values of $m\sin^3 i$ are rough estimates and are systematically too large in so far as they are based on double-spectrum binaries, this is not a serious objection for the limited object in view, unless they are excessive. This latter contingency has not arisen because it would be shown in the discontinuity between the double- and single-spectrum system, and continuity in this respect is clearly brought out in the investigation. It seems a rash step to assume standard values of $m\sin^3 i$ and to apply them to individual systems, but, as Prof. Plummer points out, the results speak for themselves, and though in the lengthy Table iv they may be faulty in detail, nevertheless in broad outline they appear fairly correct.

'Spawning Urge', 'Homing Instinct', and 'Waiting' in Salmon Return

By Dr. A. G. Huntsman, Biological Board of Canada

NOT infrequently we misinterpret the mental processes of our closest friends—why they do certain things—and have to be corrected by them. If we misinterpret the mental processes of salmon, we can have no hope that they will correct us. From certain facts we may infer that salmon under the impelling force of a 'spawning urge' travel to their natal rivers by virtue of a 'homing instinct', and 'wait' at the mouths of the rivers until the conditions are right for their ascent, but we can have no hope of knowing these things, which are unverifiable assumptions. It is true that these conceptions are of very distinct value in presenting a readily appreciated picture of salmon behaviour, but are they the best for the scientific investigator? There can be no objection to them if, known for what they are, they are in quite full agreement with the facts. I do not wish to be an iconoclast, since 'images' have value, but, if they make us blind to realities, it seems desirable that we should see them as they are, even if we do not get rid of them. What are the realities?

Some years ago 'sea trout' (*Salvelinus fontinalis*) were trapped for hatchery purposes when ascending the Margaree River in Cape Breton Island during mid-summer. At spawning time, about forty per cent of these fish failed to yield spawn. We have examined this summer run and have seen that it consists in part of fish well along toward sexual maturity and in part of fish that are quite immature. To save the theory of a spawning urge, it is customary in such cases to make another unverifiable assumption—that the immature fish are carried along by the example of the others. In the Atlantic salmon (*Salmo salar*), very occasionally an immature fish is taken in summer with those that are maturing, but in the Saint John River of southern New Brunswick there is a condition in which the runs of maturing and immature fish are distinctly separated in time, so that no influence of example can be given as the explanation of the entrance of the immature into the river. There are three principal lots of fish entering the Saint John: (1) the grilse (1 + years in the sea, about 6 lb. in weight), practically all males and maturing, which enter in summer; (2) the fall or winter fish (1 + years in the sea, about 9 lb. in weight), practically all females and immature, which enter from November to January; and (3) the ordinary salmon (2–2 + years in the sea, averaging 10–15 lb. in weight, and increasing as the season advances), mostly females and maturing, which enter from May to July or August. However these facts may be viewed, there is no agreement between sexual maturity and entering the river. The gaspereau (*Pomolobus pseudoharengus*) spawns in the spring, and the mature fish enter the Margaree River at that season. But later, first the two-year-olds and then the yearlings also enter the river and pass through the estuary to fresh water, yearlings being taken even some distance above the head of tide. The conception of a 'spawning urge' inevitably obscures whatever may be the proper explanation of the return to, and ascent of, rivers by anadromous fishes.

There is a fascination in the wonderful. On the basis of certain facts and absence of facts, there has developed the view that the salmon migrates with almost unerring instinct from some distant feeding place in the sea, where salmon have never or rarely been taken, to its natal river. It is now clear that there is no known instance of a salmon making such a journey, whatever might be its mental process in doing so. It has been observed that the Atlantic salmon of the two Apple Rivers at the head of the Bay of Fundy, with a common narrow estuary, are in the outer part of the estuary, which never drains, and along the neighbouring coast, during the summer season when they are active. When sluggish in winter or when busy feeding they would not be seen. There is nothing to indicate that they have ever been in the open ocean or even out in the Bay of Fundy. They are thus more or less within the influence of the water issuing from their rivers. Under certain conditions of river discharge, usually starting in September, they go with rising tide up the estuary and into one or other of the two branches. We do not know whether each fish chooses its own branch when it reaches the fork in the estuary, but there is no necessity for its doing so, since by entering the branches at random, it has merely to remain in the right one. Certainly in the branched Miramichi estuary of northern New Brunswick, a salmon caught and 'tagged' in the Northwest Miramichi on September 24, 1930, was recaptured four days later in the Southwest Miramichi[1], having travelled nine miles down one branch of the estuary, fourteen miles up the other branch to the head of tide and twenty miles farther up above the head of tide. In any event, the salmon of Apple estuary have in an experiment shown relation to their own rivers[2]. Those of East Apple River were definitely recognizable, having been marked when descending as smolts. Traps were operated on both rivers just above the head of tide when the fish were returning. From the time when they began to ascend until close to spawning time, only marked salmon ascended East Apple River and no marked salmon ascended West Apple River. Later, however, even more marked salmon ascended the latter river than the former, so that no relation was seen near spawning time. This is the most precise experiment of the kind that has yet been reported. There is no evidence of the salmon doing anything more definite in 'homing' than to remain in the water of its own river if it happens to reach it.

Certain facts have given rise to the belief that salmon, on reaching the mouths of their rivers, 'wait' until the conditions are right, before venturing to ascend. There is no doubt that their failure to ascend is one of the great worries of the angler, and also that at times they have been seen congregated at a river mouth. While the latter observation quite fulfils the idea of 'waiting', it is only inference that they do anything more than remain there for a time, and this may be essentially the same as the behaviour of trout in a trout-pond, which congregate where the

water supply rushes in. Turbulent current causes salmon to remain quiet, as a precise experiment performed this past summer clearly showed. Salmon parr in the bottom of a tank were moving about when the water was still and immediately became quiet when a current was started, resuming their to and fro movements when the current was stopped. Indeed, the usual behaviour of salmon that will ascend the river under proper conditions seems to be to go to and fro. The capture of salmon in drift nets in and near river estuaries, such as Avon River, N.S., the Petitcodiac River, N.B., and the Saint John River, is dependent upon such movements of the salmon[3]. A to-and-fro movement with a range of at least fifty miles has been demonstrated in tagging experiments[4]. The conception of 'waiting' is not in agreement with the facts.

[1] Blair, A. A., *Ann. Rep. Biol. Bd. Canada*, 1933, 16 (1934).
[2] White, H. C., *J. Biol. Bd. Canada*, **2**, 391 (1936).
[3] Huntsman, A. G., *Bull. Biol. Bd. Canada*, **51**, 5 (1936).
[4] Dahl, K., *Salmon and Trout Mag.*, **88**, 229 (1937).

British Industries Fair

TO anyone who has visited the British Industries Fair over a period of many years two features must have become increasingly evident. One is the extent to which scientific knowledge, methods and equipment are being used in industry, and the other the birth and growth of new industries which are the direct offspring of scientific discoveries.

At Olympia this year, the exhibits of plastics present a very good illustration of the second feature. The range and the variety of the finished plastic products available for all sorts of industrial and domestic purposes seem to increase each year. Indeed, in the prolific character of the researches into synthetic resins and kindred investigations, one is almost inevitably reminded of the fertility of the investigations into coal tar which gave birth to the vast aniline dye industry. The exhibits of plastics, indeed, now constitute one of the major features of the Fair at Olympia. Among the new products to be seen this year was a cast, phenolic resin, known as 'Catalin', which was exhibited for the first time by Catalin Ltd. The material is non-inflammable, odourless and tasteless, resistant to alcohol and oils and to most of the common acids. It is claimed, moreover, to have high di-electric and compressive strength. Catalin is not a moulded product, so that moulds, presses or dies are not required. It is supplied to the customer in cast, solid form and can be converted into the finished product by the use of standard machinery, tools and manufacturing equipment. Mouldrite Ltd. showed several samples of modern plastics, including phenol-formaldehyde, urea-formaldehyde and acrylic moulding powders and resins. The transparent synthetic product, 'Perspex', to which reference was made in the review of the Fair last year (see NATURE, 139, 380; 1937), was a prominent feature of this stand. This material is being widely adopted for use in aircraft as windscreens, cockpit coverings, cabinet windows and gun turrets. Combined Optical Industries Ltd. exhibited several examples of plastic lenses produced by special moulding processes. These included ophthalmic lenses, simple lenses, opera oculars and objectives, and camera view finders and meniscus objectives. The synthetic, plastic product used as the raw material for these optical elements is said to have optical properties that compare favourably with those of glass. In refractive index and dispersion it resembles crown glass, and it has a higher transparency than glass, especially in the ultra-violet. One most interesting feature of this new product is the number of new possibilities it creates for the use of aspherical lenses. These plastic lenses are practically unbreakable, less than half the weight of corresponding glass lenses and chemically inert.

The exhibits of chemicals were under the auspices of the Association of British Chemical Manufacturers and this section shared pride of place with the scientific instrument section. It is interesting to note that, according to the Board of Trade official statistics, home products are increasingly replacing imported chemicals. The main increases in British exports of chemicals during the past year have been in respect of bleaching powder, sodium carbonate, caustic soda, ammonium sulphate, fertilizers, dyestuffs, cresylic acid, tar, creosote oils and copper sulphate. Among a number of products, which are either new or are being offered in new form, the following may be noticed: sodium alginate—a reactive colloid used for controlling viscosity; terpeneless oils, which are invaluable in fine grade perfumery products; and a range of dyes for anodic colouring of aluminium.

The exhibit of Imperial Chemical Industries, Ltd., this year was confined to a display constituting an historical survey of the manufacture and uses of 'alkali', from the time of ancient Egypt, when it was used for glass-making and embalming, through its agricultural production in the Middle Ages, through the development of the Le Blanc process at the end of the eighteenth century, down to the introduction of the ammonia-soda process in the middle of the nineteenth century. A number of interesting historical exhibits was appropriately included in this ingenious display which, with the various notes attached to the several exhibits and with a leaflet entitled "The Story of Alkali", constituted a really fascinating and informative lesson for the visitor who had time to give careful attention to it. Attention was directed to the technical service of the alkali group of Imperial Chemical Industries, Ltd. One of the latest successes in this service has been in the refining and desulphurization of iron.

Among other exhibits in the chemicals section we may note that British Drug Houses, Ltd., showed specimens of plant hormones reproduced by synthesis in the laboratory. The Gas Light and Coke Co. showed a non-toxic tar for use on roads in the vicinity of fishing streams—an interesting example of an attempt to meet special needs.

The combined exhibit of the scientific instrument manufacturers, to which reference was made in NATURE of February 26, p. 362, was an imposing display which, as was said above, shared pride of place with the chemicals section. The layout and the arrangement of the several exhibits were dignified and effective, and those responsible for its organization

are to be warmly congratulated. One general feature, which was evident at last year's Fair and still more evident this year, was the increase in the number of scientific instruments used for industrial purposes, either for routine testing, for the control of operations or in the field of scientific investigation. This tendency, it is safe to predict, will grow, and the extent to which it grows will form a fairly reliable indication of the extent to which scientific knowledge and scientific methods are permeating industry in general.

It is impossible, within the limits of an article, to do justice to all the points of interest in the combined exhibit of the scientific instrument manufacturers. Among the novel exhibits, C. Baker showed the 'Smith wear and lubricant tester'. This instrument has been designed and developed with the object of producing a reliable means of testing and investigating, by means of the same instrument, the hardness and wearing properties of various metals and also the lubricating and abrasive qualities of lubricants. Accordingly, the machine can be used to assist in the selection of the best lubricant for a given bearing or in the choice of bearing metal for a given purpose. The machine uses the principle common to certain other instruments, in which the revolving member wears a measurable impression in the flat surface of a test piece. It is, however, unique in many respects and particularly in that it employs as a wearing member a hardened steel ball of 1 cm. diameter, exactly as is used in the Brinell hardness tester. Cooke, Troughton and Simms, Ltd., exhibited several new designs of surveying instruments, in which the size and weight have been considerably reduced without loss of accuracy, and the ease of reading the circles and the general facility for handling have been increased. Among these instruments, attention may be directed to the 'geodetic Tavistock theodolite', which reads to half a second of arc. In this instrument, the mean of the readings at both ends of a circle diameter is automatically indicated. The circle graduations are permanently marked on optical glass and both circles are read from a position near the eye-end of the telescope, whichever face is being read. This firm also showed a Vickers projection microscope, for which very great stability and rigidity are claimed. It is capable of carrying specimens up to 50 lb. in weight without any risk of damage.

Adam Hilger, Ltd., showed the 'Spekker photo-electric absorptiometer'. The principal advantage of this absorptiometer over the colorimeter of the Duboscq type is that visual matching is entirely eliminated. This firm also exhibited a new large spectrograph for metallurgical spectrum analysis. It is of the Littrow type and is unique in this respect, that it is the only type of spectrograph in the world in which all the adjustments are made automatically, simultaneously and accurately. One handle only is needed to effect these adjustments. W. Watson and Sons, Ltd., showed, among other exhibits, a profile projector and the Watson-Symon 'enlarging calculator'. The latter instrument is used in the production of enlargements of the highest standard from miniature negatives. It is claimed that the instrument can be used in combination with any type of enlarger and for any size of enlargement. R. and J. Beck, Ltd., exhibited Dr. G. M. B. Dobson's 'ozone spectrometer'. It is claimed that by means of this instrument the thickness of the layer of ozone thirty miles above the earth can be measured and, from the measurement, a speedy and accurate weather forecast can be deduced. A comprehensive range of television receivers and equipment was shown on the stand of Baird Television, Ltd. The receivers incorporated a 'Cathovisor cathode ray tube', which is completely electro-magnetic in operation. A multiplier photo-electric cell was also shown and television lecture equipment for use in colleges and technical schools.

In view of the work on which the scientific instrument firms must be busily engaged in connexion with the great rearmament programme, it was no doubt difficult for many firms to exhibit at all and, for those firms who did exhibit, to give as comprehensive and detailed a picture of their industrial products as they would have liked. Nevertheless, as has been indicated, the scientific and optical instruments combined exhibit was a significant object lesson of the scope and vigour of this very vital industry.

Punjab Irrigation Research Institute*

THE scope of the work undertaken by the Punjab Irrigation Research Institute, the director of which is Dr. E. McKenzie-Taylor, is illustrated in three publications, giving the results of different inquiries which have recently been pursued. In "The General Theory of the Gradient of Pressure under a Structure on Permeable Foundations" Mr. J. K. Malhotra and Dr. McKenzie-Taylor build up from first principles a general theory in conformity with the formulæ and values obtained by other workers for the rate of change of pressure in the direction of flow. Treating first the case of flow under a simple floor, a general expression for exit gradient is obtained, and this is extended to the case of flow under a complex structure, several specific cases being dealt with in order to show its applications.

The second of these publications takes us from the structural interests of the Institute to that of cultivation. In the Punjab, it has been the custom to regard land suitable for rice as unfit for other crops, but the improvement noted during investigations on reclaimed land tends to rebut this view. It is probable that land, which when first reclaimed is only fit for rice, can be improved to such an extent as to be capable of producing a normal rotation of crops. This is suggested in "The Soils of the Rice Areas of the Gujranwala and Sheikhupura Divisions of the Upper Chenab Canal" by Mr. M. L. Mehta.

In parts of the district referred to, the water table has risen considerably and, in consequence of the increased salt content and alkalinity, the land has gone out of cultivation. The objects of the investigation described were to determine the soil characteristics and the degree of deterioration of these lands as a first step towards their reclamation.

* Punjab Irrigation Research Institute. Research Publications. Vol. 2, No. 16. Pp. 10. 3 annas, 4*d*. Vol. 3, No. 2. Pp. 25+iii+4 plates. 10 annas, 1*s*. Vol. 3, No. 3. Pp. 47+10 plates. 1·3 rupees, 1*s*. 10*d*. (Lahore, 1937).

From the numerous examinations of soil samples taken, certain areas where salt and alkalinity are high were indicated as being fit, as yet, only for rice crops. Others proved to be of better quality, and it is held that the failure to appreciate this is due to lack of knowledge of the proper method of rotation, the essential feature of which is to introduce a leguminous crop immediately after the rice in order to restore the nitrogen balance. The anærobic soil conditions under which rice is grown have the result of reducing the nitrogen available for the succeeding crop. A study of the natural flora of the area showed that these gave reliable indications as to the state of the land.

This forms an interesting commentary on the third of these researches, which was suggested by the dominance of particular types of natural flora noticed in certain localities surveyed in 1931–32. The purpose of this investigation was to determine the class of soil favoured by each of the five types of vegetation selected, as a guide in future soil surveys. In "A Study of the Soil Profiles of the Punjab Plains with Reference to their Natural Flora" R. C. Hoon and M. L. Mehta deal fully with each case, and, in the result, show that four of the botanical types referred to—*Prosopis spicigera*, *Salvadora oleoides*, *Tamarix articulata* and *Capparis aphylla*—are reliable indicators of the soils they favour, and deductions may be drawn as to the crops for which they are suitable and the precautions necessary when under irrigation and treatment. In conjunction with grass (*Eleusine ægyptica*), however, a wide range of soils was found and from this type of vegetation, therefore, no index value was obtainable.

The Aliphatic Diazo Compounds

IN the forty-second Bedson Club Lecture delivered in King's College, Newcastle-upon-Tyne, Prof. J. Kenner discussed the aliphatic diazo compounds. The observation that the naturally occurring amide asparagine lost nitrogen when nitrous acid was present in nitric acid used for its hydrolysis led to the discovery of the general effect of this substance upon aliphatic amines. The work of Griess on aromatic diazo compounds was followed by the discovery of diazo acetic ester by Curtius, who turned to good account the suggestion of Baeyer that the acid part of glycine should be esterified whilst investigation of the amino group was proceeding. Together with Buchner, Curtius described the properties of the new substance which are responsible for the importance of its congeners to-day.

With regard to the formula of the aliphatic diazo compounds Curtius favoured the cyclic structure,

but Thiele was led by observations of Staudinger and himself to propose R.CH = N ≡ N. Modern theory regards these compounds as examples of mesomerism, and the suggestion was now put forward that their formation from the diazo-hydroxides first produced, for example, in the preparation of diazomethane from nitrosomethylurethane, is due to the peculiar stability of the mesomeric state.

Prof. Kenner's active interest in the subject arose from his investigations of the tendency of the nitroso-group to pass whenever possible into the oximino-group. This led to an improvement of the early von Pechmann preparation of diazo paraffins, consisting in brief in the alkaline decomposition of the N-nitroso derivative of the addition product of mesityl oxide and a primary aliphatic amine.

On the larger scale, certain difficulties were encountered. Loss was occasioned by the liberated diazoparaffin combining with the mesityl oxide simultaneously formed, but was reduced by working at lower temperatures and by separating mesityl oxide from the distillate by a fractionating column. In the case of higher homologues the boiling points of which approximate to that of mesityl oxide, pulegone can with advantage be substituted for the latter, in the preparation of the nitroso compound. Ether, first used to carry away the diazo compounds, was recognized by Meerwein to inhibit their reactivity, but a very satisfactory technique was developed in which anisole is used as solvent and nitrogen as a carrier gas under reduced pressure.

Vinyldiazomethane and its methyl derivative exhibit a comparatively feeble reactivity towards acids; this was attributed to internal saturation, and in agreement with this the vinyl compound readily passes by monomolecular reaction into pyrazole.

After a discussion of some of the properties of the aliphatic diazo compounds, their chemical behaviour was discussed and more particularly towards ketones. The inertia of these towards diazomethane was first overcome when Meerwein activated acetone by means of methyl alcohol. The initial attack of the diazo compound at the carbon atom of the carbonyl group is followed by loss of nitrogen and stabilization, either by formation of an ethylene oxide ring or by a Wagner-Meerwein type of rearrangement. This latter, in the particular case of cyclic ketones, results in ring enlargement; cyclo-hexanone, for example, gives on treatment with diazomethane, 46 per cent cyclo-heptanone. Similar reactions have been carried out with the homologues of diazomethane (which are more reactive than the parent substance), and numerous 6-, 7- and 8-membered 2-alkyl cycloketones have thus been prepared. The same products were prepared directly from the corresponding nitrosourethanes by a procedure applied by Meerwein to nitrosomethylurethane, and this has the advantage of applicability in cases in which it may not be possible to prepare the diazo compound itself. By this device also it is possible to introduce groups into a ketone which may be of use in further synthetic operations.

Science News a Century Ago

Colonel John Stevens (1749-1838)

COLONEL JOHN STEVENS, of Hoboken, New Jersey, who died on March 6, 1838, although not trained as an engineer was for fifty years one of the chief pioneers of the use of steam for transport on land and sea. The grandson of John Stevens, who as a youth of seventeen went from London to New York to serve in a lawyer's office, and the son of "the Honorable John Stevens, Gentleman", a successful business man and a figure in the American political world, Stevens graduated from King's College—now Columbia University—in 1768 and for a time studied law. He was always possessed of ample means, and during the Revolution he acted as treasurer of New Jersey, attaining the rank of colonel. In 1784 he purchased large tracts of land in New Jersey, including Hoboken on the west bank of the Hudson. His interest in steam boats was stimulated by the work of Rumsey and Fitch and in co-operation with Nicolas Roosevelt and Chancellor Robert Livingston he constructed steam boats himself. Of these, the most notable was the *Little Juliana*, 1804, which he fitted with a multitubular boiler and a high-pressure engine driving twin screws. This was the first practical screw-driven steam boat. The machinery of the boat is preserved in the United States National Museum.

In 1807, Stevens constructed a paddle wheel vessel the *Phœnix*, which made a trip from New York to Philadelphia, this being the first voyage by a steam boat in the open sea. Later on he started a steam ferry-boat across the Hudson. He wrote much on the improvements of roads and was a prominent advocate of steam railways. In 1815, he applied for and received from the State of New Jersey the first American railway charter, and when seventy-six years of age constructed the first locomotive in America and ran it round a circular track on his estate. He retained his mental vigour to the last. Of his family, John Cox Stevens, Robert Livingston Stevens and Edwin Augustus Stevens also did much for furthering transport in the United States, and the last, by his will dated 1867, provided for the erection and endowment of the well-known Stevens Institute of Technology, Hoboken, N.J.

Structure of Vegetable Tissue

ON March 8, 1838, the Rev. Joseph Bancroft Reade (1801–70), the chemist and microscopist, read a paper to the Royal Society entitled "An Inquiry into a new Theory of Earthy Bases of Vegetable Tissues". After briefly noticing his experiments described in two papers in the *Philosophical Magazine* of July and November 1837, he adverted to the theory of M. Raspail detailed in his "Tableau Synoptique" and "Noveau Système de Chimie". In opposition to some of the views entertained by Raspail, Reade found that in the bark of the bamboo and the epidermis of straw the silica incrusting these tissues is not crystallized, but on the contrary exhibits, both before and after incineration, the most beautiful and elaborate organization, consisting of an arranged series of cells and tubes, and differing in its character in different species of the same tribe and in different parts of the same plant. The observations of Mr. Golding Bird were referred to, and Reade stated in confirmation that, by employing caustic potash, the siliceous columns may be removed from the leaf of a stalk of wheat, while the spiral vessels and ducts which form the principal ribs of the leaf, as well as the apparently metallic cups, which are arranged on its surface, remain undisturbed. He proposed, therefore, to substitute, in the description of vegetable tissues, the term skeleton, instead of that of bases, whether saline or siliceous, of those tissues.

The Mass of Uranus

AT a meeting of the Royal Astronomical Society on March 9, 1838, a paper by Dr. J. Lamont was read on the "Value of the Mass of Uranus deduced from Observations of its Satellites made at the Royal Observatory of Munich during the year 1837". In the course of the year, opportunity of a few favourable nights was taken to observe the satellites with the view of calculating the mass of the planet. Though the object was not satisfactorily attained, the results were not without interest as it led to the conclusion that the true mass of the planet was considerably smaller than that generally adopted. The value he found was 1/24605, being less by one fourth part than that obtained by Bouvard, from the perturbations produced by the planet. Lamont remarked that in giving this value he was aware of the uncertainty of the data on which it rested. He was confident that the value of the mass of Uranus, then used in the theory of the planetary perturbations, ought to be greatly diminished, though the precise proportion in which this should be done could not then be assigned.

Lamont was born on December 13, 1805 at Muckle Inverey, near Braemar, Aberdeen, but at the age of twelve years was sent to the Scottish Benedictine Monastery at Ratisbon, Bavaria. He was made director of the Munich Observatory in 1835, devoting much of his time to terrestrial magnetism. He died at Bogenhausen, Munich, in August 1879. In September 1934, Princess Arthur of Connaught unveiled a memorial to him at his birthplace.

Whewell's "History of the Inductive Sciences"

IN a long review, in the *Athenæum* of March 10, 1838, of Whewell's three-volume work "History of the Inductive Sciences from the Earliest to the Present Times", the reviewer towards the end of his article proceeded "to endeavour to pronounce at once a distinct opinion on the merits of the work before us. We find," he wrote, "in that work abundant proofs of profound and varied knowledge, great power of language, impartiality of judgment, and even boldness of thought; but unfortunately the ambition of eloquence seems to have enticed the author into a style not always the most appropriate to his subject. His style is that of one whose mind is used not to originate, but to receive ideas—not to unfold, but to grasp them: in his efforts to express himself clearly he usually becomes sententious. He leans towards transcendental truths and expressions; and while from its want of elemental ideas and simple language, his work will be always unintelligible to the bulk of people, we fear that those who by their knowledge of physical science are capable of understanding it, may have reason to complain of its want of originality and acuteness, of breadth of view and insight into the reciprocal action of the various branches of human knowledge; or to lament that it chronicles the increase of science, without throwing much light on the history of the human mind."

University Events

BIRMINGHAM.—The Poynting Memorial Lecture will be given on March 11th at 5.30 p.m., at the University, Edmund Street, by Dr. E. C. Bullard, who has chosen as his subject "Geophysical Measurements at Sea". The lecture will be open to the public.

LONDON.—Prof. G. M. Bennett has been appointed professor of chemistry tenable at King's College. Since 1931 he has been Firth professor of chemistry in the University of Sheffield (see also p. 403).

Mr. R. S. Pilcher has been appointed professor of surgery at University College Hospital Medical School. Since 1934, he has been first assistant in the Surgical Unit and, since 1936, assistant surgeon at University College Hospital.

The title of professor emeritus of pathology in the University has been conferred on Prof. A. E. Boycott, formerly Graham professor of pathology in University College Hospital Medical School.

The following doctorates have been recently conferred: D.Sc. in chemistry on E. D. Hughes, of University College, and W. Taylor, of the Sir John Cass Technical Institute; D.Sc. in physics (spectroscopy) on W. H. J. Childs, of King's College.

The following, among others, have been appointed fellows of King's College: Mr. E. R. Bolton, a member of the Chemical Engineering Committee; Lieut.-Colonel R. D. T. Alexander, president of the Institution of Engineers (India) in 1928.

Among those recently elected to the fellowship of University College, London, are: Dr. E. J. Allen, formerly secretary of the Marine Biological Association of the United Kingdom, and director of the Association's laboratory at Plymouth; Dr. H. L. Eason, principal (formerly vice-chancellor) of the University of London; Prof. E. Mapother, medical superintendent and professor of psychiatry at Maudsley Hospital; Mr. A. S. Quartermaine, assistant chief engineer of the Great Western Railway; Mr. C. C. Walker, chief engineer of the De Havilland Aircraft Company; Mr. C. S. White, senior obstetric surgeon in University College Hospital; Mr. J. A. Wilks, librarian of University College.

ST. ANDREWS.—The following appointments have recently been made: H. G. Campbell to be the first professor of dental surgery; G. A. Cumming to be lecturer in geology and geography; J. Dewar to be lecturer in chemistry in the United College; Dr. D. Stiven to be lecturer in bacteriology and assistant director of the Bacteriology Laboratory.

Societies and Academies

Paris

Academy of Sciences, January 10 (*C.R.*, 206, 81–136).

LUCIEN CAYEUX: The role of the Foraminifera and of calcium carbonate in the fixation of certain mineral substances.

JEAN CABANNES and AUGUSTE ROUSSET: The Raman effect in gases under pressure.

MARCEL GODCHOT and MLLE. GERMAINE CAUQUIL: The menthadienic hydrocarbons obtained in the dehydration of the active and inactive 1-methyl-3-cyclohexylisopropyl pinacones.

ERNEST VESSIOT: The equations $F(x,y,z,p,q,r,s,t)=0$ to which the method of Darboux is applicable.

HENRI PONCIN: The commencement of flow of a viscous fluid.

LÉOPOLD ESCANDE: Flow through a gate valve.

PIERRE DIVE: The impossibility of permanent barotrope rotations in a fluid star with ellipsoidal stratification.

RAOUL GOUDEY: Measurements of the acceleration of gravity made in France during the year 1934. Values of g for 58 places in France are tabulated.

HENRI LACOSTE-TAYAN: The aerial *permeance* of permanent magnets.

MLLE. SYLVANIE GUINAND and JACQUES NICOLLE: The rotatory power of mixtures of ascorbic acid and soda.

FRANTZ PERRIER: The radiation emitted by solid dielectrics electrified by friction. The existence of this radiation having been doubted by Eichenberger, additional experiments made with further precautions as regards screens are described. The author still upholds the reality of the radiation.

MLLE. YVETTE WORMSER: The action of oxalic acid on a cobaltichloropentammine.

MARCEL FRÈREJACQUE: The identification of glucose. The acetolysis of the glucosides. The method is based on the production of β-tetracetylglucosylparatoluidine. This has definite and easily recognizable properties, and can be made from the products of hydrolysis of a glucoside without difficulty.

V. DOLEJŠEK and M. JAHODA: The variations of the network of piezo-electric crystals produced by a static electric pressure.

MARIUS DALLONI: The Permian deposits of the Pyrenees with Angaride flora.

ANDRÈ LENOBLE: The age and chronological order of the eruptive outbreaks between Mahanoro and Nosy-Varika (eastern coast of Madagascar.

GASTON DELÉPINE and BRANKO YOVANOVITCH: The presence of Famennian grit and coralligenous limestones of the middle Devonian at Mechra ben Abbou (western Morocco).

PAUL DELEAU: Sudden variations of facies of the lower Cretaceous at Djebel Djaffa (Constantine).

OTTAVIO MUNERATI: The culture of the beetroot from seed to seed in a simple liquid medium.

ROGER GAUTHERET: Transplanting cambium tissue cultures of *Salix caprea*.

CONSTANTIN DAWYDOFF: Asexual multiplication by laceration in *Ctenoplana*.

MARIUS PIÉRY, JEAN ENSELME and MLLE. SIMONE PETEL: Researches concerning the influence of mineral waters on tissue respiration. Role of the ions Ca^{++}, Mg^{++} and Na^{+}.

MME. ANDRÉE ROCHE, JEAN ROCHE, MME. SIMONE DROUINEAU and PAUL PASSELAIGUE: Capability of a protein food to meet the nitrogenous needs of maintenance or of growth and regeneration of tissue proteins.

SERGE TCHAKHOTINE: Ultra-violet ultra-micropuncture: a new means of studying colloidal phenomena in the living cell.

Geneva

Society of Physics and Natural History, October 21.

PAUL ROSSIER: (1) The apparent diameter of the star α-Leonis. The author shows that the various formulæ proposed for calculating the apparent diameter of a star agree with the results of observations

made by Arnulf and based on the method of occultations. This result is the more remarkable since it has been obtained by examining a hot star. (2) The separating power of the prism objective. It is easy to prove that the separating power of the prism is slightly below that of the objective and that these two objects agree with each other if their diameters are equal. As the dispersion increases with the angle of the prism, it would appear to be advantageous to increase this angle as much as possible. In reality, for photometric reasons, this is made relatively small.

November 18.

JEAN LOUIS PERROT: The descent of the ovocytes in *Helix Pomatia*. The receptivity of the ovocyte does not appear to be connected with a determined stage of maturation, but rather on its position in the genital tract. Whatever may be the state of nuclear division of the ovocyte, it is fertilized only when it has penetrated into the fertilizing chamber.

MAX PERROT: Researches on the chromosomes of the *pulmonés stylommatophores*. The results of numerous counts of chromosomes carried out especially in the Helicidæ family leads the author to attribute to the sub-family of the Helicinæ the characteristic chromosome numbers 22, 25, 26 and 27.

EMILE CHERBULIEZ, JEAN JEANNERAT and KURT H. MEYER: Collagen A, collagen B and gelatin. A study of the fibres of calf's foot tendon has shown that in the passage from the original collagen to gelatin two sorts of transformations must be distinguished. First, a physical transformation consisting of a loss of the crystalline structure of the primitive fibres, and secondly, a chemical transformation characterized by a commencement of hydrolysis which splits up the long polypeptic chains. The usual collagen B is a product arising from collagen A by an intra-micellular fusion (transformation 1) accompanied by a beginning of hydrolysis of variable intensity depending on the treatment adopted. Hence collagen B is not a product showing constant properties.

December 2.

ARNOLD LILLIE and WILLY J. SCHROEDER: The Nummulitic of the valley of Chambres (Nappe de Morcles, Samoëns Alps, Haute-Savoie). The detailed study of a Nummulitic series shows (1) the presence of a fauna of foraminifera altered from the Upper Cretaceous; (2) a Lutetian marine intrusion; (3) a series of red intermediate layers between the marine Lutetian and a complex conglomerate series; and (4) a complex conglomerate series intermediate between the Lutetian layers containing Lutetian nummulites and those containing Priabonian nummulites.

AUGUSTIN LOMBARD: Polygenic conglomerates of the base of the external Pre-Alps (Voirons, Pléiades, Collines du Faucigny). (1) Distribution, lithology. Conglomerates are found at Voirons analogous with those discovered in the external Pre-Alps. They are arranged in a series of lenses in contact with the molasse and the ultra-Helvetic flysch. (2) Problem of their origin. The polygenic conglomerates of Voirons are detritic Taveyannaz grits of Priabonian age transported over a distance of about 30 kilometres, and autochthonous formations identical with those of Clusaz.

CHARLES G. BOISSONNAS: The calculation, for a binary mixture, of the partial vapour pressures starting with the total pressure. The knowledge of the total pressure of the vapour in equilibrium with a binary solution, as a function of the molecular composition of the condensed phase, suffices for the calculation of the partial pressures.

A. J. A. VAN DER WYK: The viscosity of binary mixtures. It is impossible to describe the viscosity of a mixture without the introduction of a new magnitude called 'binary viscosity', some applications of which are indicated.

MADELEINE BLANC and JEAN WEIGLE: Simultaneous reflections and deflected action. It can be shown that the intensity of the apparent reflection of X-rays on planes with zero coefficient of reflection can be of the same order of magnitude as on planes with the coefficient not zero. The energy which flows in the originally inhibited direction cannot arise directly from the incident wave.

JEAN WEIGLE: The double refraction of an atomically stratified medium. Waves propagated in a stratified medium give double refraction. The velocities of the resulting waves are represented by an ellipsoid and by a sphere which are the Fresnel surfaces.

JEAN PATRY and JEAN WEIGLE: The conditions at the limits in problems of diffraction by periodic media. The authors have established the conditions at the limits, in a periodic medium traversed by waves, that determine those of the waves which will be excited by an external wave falling on the medium.

Rome

National Academy of the Lincei (*Atti*, **25**, 679–746; 1937).

F. SEVERI: Systems of equivalence of any species on one algebraic variety, as rational systems (2).

G. SCORZA: Algebras linked to groups of finite order.

S. CHERUBINO: Application of holomorphous functions of matrices to systems of linear differential equations (2).

M. VILLA: Differential property of the cones of Veronese.

G. COLONNETTI: Elastic equilibrium of systems in which non-elastic deformations also occur (4).

E. DE ANGELI: Some integrable cases of movement of a heavy asymmetric gyroscope.

F. DE FRANCHIS: Links and reactions in the most general scheme of Lagrange.

M. G. FRACASTORO: Eruptive protuberance of May 29, 1937.

G. BOAGA: Relationships between the deviations of the vertical and the gravimetric anomalies.

A. BARONI: Sulphur selenium protochloride. Determination of the index of refraction and of the surface tension of mixtures of sulphur in selenium protochloride Se_2Cl_2.

C. PERRIER and E. SEGRÈ: Some chemical properties of element 43.

G. PICCARDI: Flame spectrum of europium and the persistence of three lines of low excitation.

P. COMUCCI: A singular rock from the Baltoro glacier (Karakorùm) (2).

E. MARCHESINI: Extension of the Oligocene in the region north-east of the Monte Judica group (Provinces of Catania and Enna).

T. PERRI: Researches on the histological modifications of the thyroid in the guinea pig during the œstrus cycle.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Monday, March 7

UNIVERSITY OF LONDON ANIMAL WELFARE SOCIETY (at University College, Gower Street, W.C.1), at 5.15.—Dr. A. H. B. Kirkman: "The Disappearing Fauna of Africa: a Tragedy".*

UNIVERSITY OF LEEDS, at 5.15.—Prof. E. K. Rideal, F.R.S.: "Some Recent Advances in Surface Action".*

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—M. Hubert Carton de Wiart: "The Pan-American Highway Project".

Tuesday, March 8

KING'S COLLEGE, LONDON, at 5.30.—Prof. A. J. Allmand, F.R.S.: "The Drumm Storage Battery".*

UNIVERSITY COLLEGE, LONDON, at 5.30.—Prof. P. Pruvost: "Some Problems of Sub-Surface Geology in Northern France" (succeeding lecture on March 10).*

PHARMACEUTICAL SOCIETY, at 8.30.—F. W. Gamble: "Facing Realities" (Harrison Memorial Lecture).

Thursday, March 10

UNIVERSITY COLLEGE, LONDON, at 5.—Prof. P. E. Verkade: "The Role of Dicarboxylic Acids in Metabolism".

Friday, March 11

PHYSICAL SOCIETY (at the Imperial College of Science and Technology), at 4.45.—Annual General Meeting.

UNIVERSITY OF BIRMINGHAM, at 5.30.—Dr. E. C. Bullard: "Geophysical Measurements at Sea".*

INSTITUTE OF METALS, March 8–10.—Annual General Meeting to be held at the Institution of Mechanical Engineers.

Appointments Vacant

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

ASSISTANT ENGINEER in the Roads Department of the Ministry of Transport—The Assistant Secretary, Establishment Department, Ministry of Transport, Metropole Buildings, Northumberland Avenue, W.C.2 (March 7).

HEAD OF THE CHEMISTRY DEPARTMENT of the Wigan and District Mining and Technical College—The Principal (March 8).

DISTRICT AGRICULTURAL ORGANIZER for the East Anglian Institute of Agriculture, Chelmsford—The Clerk of the Council, County Hall, Chelmsford (March 11).

LECTURER IN MECHANICAL ENGINEERING in the Croydon Polytechnic—The Education Officer, Education Office, Katharine Street, Croydon (March 12).

RESEARCH OFFICERS for investigation into contagious abortion and swine fever and necrotic enteritis at the Veterinary Laboratory, New Haw, Weybridge—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, London, S.W.1 (March 14).

AGRICULTURAL INSTRUCTOR in Wiltshire—The Clerk of the Council, County Offices, Trowbridge (March 15).

LECTURER IN CHARGE OF THE TEXTILE DEPARTMENT in the Belfast College of Technology—The Director of Education, Victoria Street, Belfast (March 21).

ASSISTANT DIRECTOR OF CLINICAL INVESTIGATIONS AND RESEARCH (University of Manchester) in the Manchester Royal Infirmary—The Registrar, University (March 27).

LECTURER IN BIOCHEMISTRY in University College, Dundee—The Secretary, The University, St. Andrews (March 28).

DEPUTY WATER-WORKS ENGINEER to the British Municipal Council, Tientsin—Messrs. J. and A. Leslie and Reid, Civil Engineers, 72A George Street, Edinburgh, 2 (March 30).

ASSISTANT KEEPER IN ENTOMOLOGY in the Manchester Museum (University of Manchester)—The Registrar (April 20).

LECTURER IN BIOLOGY (woman) and part-time LECTURER IN GEOGRAPHY (woman) in the Southland Training College, Wimbledon Park Side, S.W.19—The Principal.

PROFESSOR OF CHEMISTRY in University College, Dundee—The Secretary, The University, St. Andrews.

Reports and other Publications

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

British Electrical and Allied Industries Research Association. Seventeenth Annual Report, October 1, 1936, to September 30, 1937. Pp. 138. (London: British Electrical and Allied Industries Research Association.) [12

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